CATALOGUE

OF THE

FOSSIL PLANTS

OF THE

GLOSSOPTERIS FLORA

IN THE

DEPARTMENT OF GEOLOGY.

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BRITISH MUSEUM

(NATURAL HISTORY).

BEING A

MONOGRAPH OF THE PERMO-CARBONIFEROUS FLORA OF INDIA AND THE SOUTHERN HEMISPHERE.

BY

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PREFACE.

Since the publication of Mr. Kidston's Catalogue of the Palæozoic Plants in 1886, extensive additions have been made to the collection in the British Museum, and much research has been devoted to these fossils. The time seems therefore to have arrived for a series of more detailed Catalogues. The Glossopteris Flora has proved to be especially important, and it is not only of great geological and botanical interest, but also of practical value to the prospectors for coalfields in India and the southern hemisphere. As this Flora has not hitherto been the subject of any comprehensive treatise, it is thus appropriately dealt with in the present volume, which is the first special Catalogue of Palæozoic Plants issued by the British Museum. The work has been prepared with much care by Mr. E. A. Newell Arber, who has been able to add somewhat to the existing knowledge, which he has critically summarised.

A. SMITH WOODWARD.

Department of Geology.
October, 1905.

AUTHOR'S PREFACE.

In this Catalogue I have made an attempt towards a complete summary of what is at present known on the subject of the Glossopteris Flora. It is hoped that reference will here be found to all the more important memoirs which have been published; a literature now not only large, but widely scattered. I have endeavoured to give some account of the less abundant, and consequently the less known species, in addition to the more characteristic types represented in the British Museum collection, and to revise, so far as possible, the older records in the light of our present knowledge. The task has not proved a light one. In many instances the rarer fossils are unrepresented in any European collection, and I have had to rely solely on the original descriptions and figures, both sometimes very inadequate, which have been published. I trust that, whatever imperfections this volume may be found to contain, it may be of use to those who are interested in the study of this ancient flora, especially to residents in our Greater Colonies of India, Australia, and South Africa, which at one time formed the principal provinces of a great southern continent, Gondwana-land, whose flora is the subject of the present work.

I have to express my acknowledgments to many friends to whom I have turned for information or advice at different times during the preparation of this volume. To Mr. A. C. Seward, F.R.S., I am especially indebted, not only for the information which he has on all occasions placed at my disposal, but for much kindly sympathy and encouragement.

To Dr. D. H. Scott, F.R.S., Professor F. W. Oliver, F.R.S., and Professor Zeiller of Paris, I would express my sincere thanks for valuable suggestions, or other aids. Mr. C. D. Sherborn has rendered me great services in connection with the literature on this flora, and to him I would return my thanks. I am similarly indebted to Mr. B. B. Woodward for assistance in the study of the periodical literature under his charge at the Natural History Museum.

My thanks are also due to Mr. Holland, F.R.S., Director of the Geological Survey of India, for particulars of the specimens in the Calcutta Museum, and to Mr. W. S. Dun, of the Geological Survey of New South Wales, for valuable information on the subject of the Australian fossils. To Mr. A. G. Hamilton, of New South Wales, I am indebted for the loan of a collection of sections of petrified woods from that colony for comparison with those here described.

The Council of the Geological Society of London have kindly given me permission to reproduce Text-figs. 12–15 from my recent paper in the Quarterly Journal, and to them I would express my thanks. For many of the other text-figures I have drawn largely on the illustrations published by the late Dr. Ottokar Feistmantel, the source in each case being duly acknowledged.

Lastly, I have to record my thanks to Dr. Smith Woodward, F.R.S., Keeper of the Geological Department, British Museum, for valuable suggestions, and to the Staff of that Department for the kindness with which they have always facilitated my work at the Museum. I would also express my thanks to Miss G. M. Woodward for drawing the illustrations included in this volume.

E. A. NEWELL ARBER.

TRINITY COLLEGE, CAMBRIDGE.
July, 1905.

NOTE.

The numbers in brackets after the Authors' names in the footnotes refer to the year of publication of the memoirs quoted. Full references to all the works cited will be found in the Bibliography at the end of the volume.

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INTRODUCTION.

THE oldest assemblage of plant-remains with which we are acquainted, in number sufficiently numerous to rank as a flora, is that of the Upper Devonian and Lower Carboniferous rocks.[1] On the present evidence, the floras of these two geological periods constitute one great palæobotanical epoch, characterised by remarkable uniformity throughout the world.[2] But when we pass to the vegetation of the succeeding Upper Carboniferous and Permian deposits we no longer find that it exhibits such a worldwide uniformity of distribution. The plant-remains of these two periods, although everywhere constituting another great epoch in the history of the vegetable kingdom, are grouped naturally in two well-marked botanical provinces. Thus one flora existed in Europe, Northern Asia, and North America, more or less contemporaneously with a dissimilar type of vegetation, confined for the most part to India and the Southern Hemisphere.

The southern flora differed remarkably in certain features from that of the Northern Hemisphere. It is now generally accepted that these two types of Permo-Carboniferous vegetation flourished on two great continental regions, for the most part, but not entirely, isolated, and widely separated from one another. The

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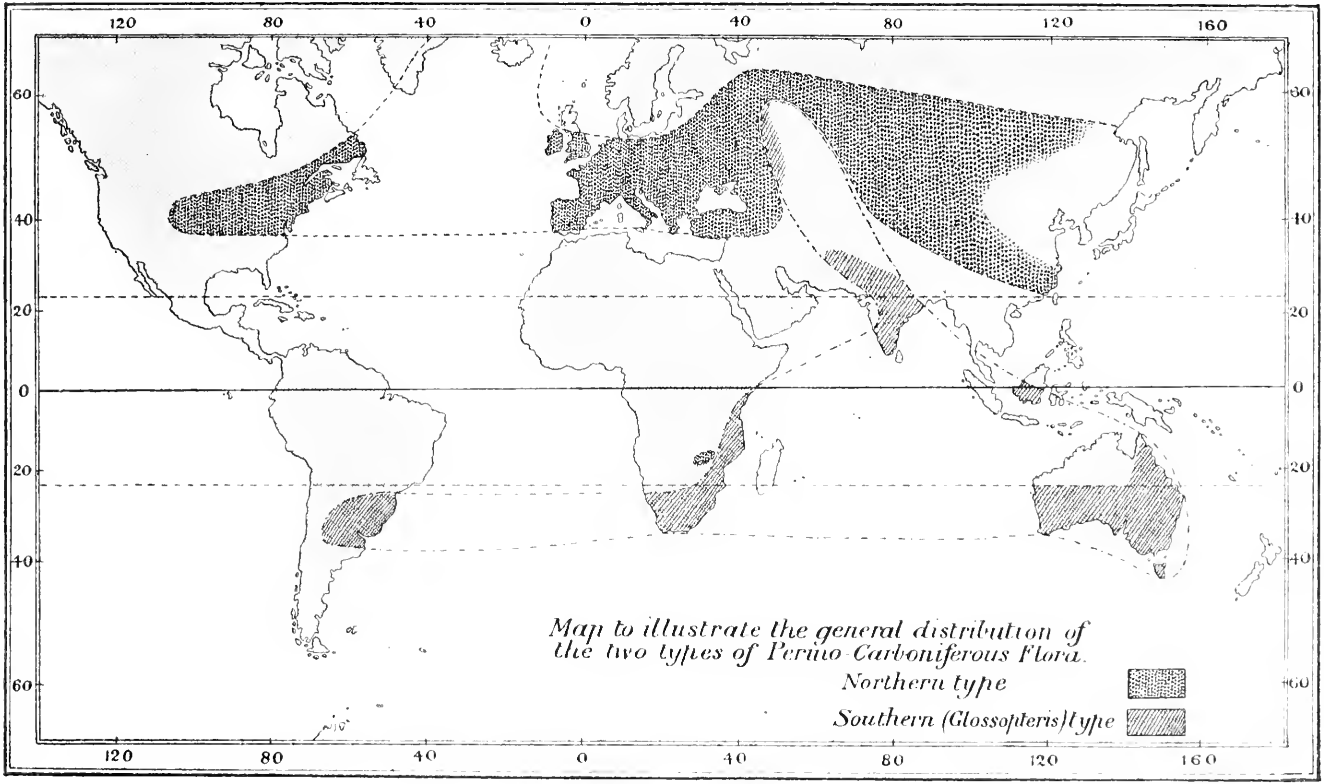
[1] The earliest known fossil plants are of Silurian age.
[2] Seward (03[2]), p. 831.

great Southern Permo-Carboniferous continent has been distinguished by Suess[1] as Gondwanaland, a term derived from the great series of fresh-water sediments in India, to which Medlicott gave the name, Gondwana system. Only the lower part, however, of the Gondwana rocks of India belong to the period under discussion.

It is with the fossil plants of Gondwanaland that we are here concerned. This flora is especially characterised by the frequent occurrence of *Glossopteris*, a fern-like plant not only of wide distribution but often found in such extreme abundance that some of the rocks of Gondwanaland appear to be largely composed of impressions of its fronds. Thus the southern type of Permo-Carboniferous flora has come to be known as the Glossopteris flora, a name first used by Neumayr[2] to distinguish it from the dissimilar, but more or less contemporaneous flora of the Northern Hemisphere. The Glossopteris flora is found typically developed in four great provinces of Gondwanaland, viz., India, Australia with Tasmania, Southern Africa, and South America. The accompanying map shows roughly the relative distribution of the Northern and Southern Permo-Carboniferous floras. At the close of the Permo-Carboniferous period, some members of the flora had become extinct, while others still survived and contributed to the vegetation of Triasso-Rhætic times, though in a subordinate degree; the survivors being no longer dominant elements in the vegetation of the early Mesozoic rocks.

In discussing this flora three main points have to be considered: (1) its botanical affinities, (2) its distribution in space, (3) the evidence as to its age and distribution in time. We may commence with a brief account of the botanical affinities of the Glossopteris flora. At the same time it must be borne in mind that our knowledge at present on this point is still very imperfect, and consequently some of the conclusions arrived at must be regarded as of a provisional nature.

[1] Suess (85), vol. i. p. 768.
[2] Neumayr (87), p. 191.


Map to illustrate the general distribution of
the two types of Permo-Carboniferous Flora.
Northern type
Southern (Glossopteris) type
120
80
40
0
40
80
120
160
60
40
20
0
20
40
60

1. BOTANICAL AFFINITIES OF THE GLOSSOPTERIS FLORA.

In order to understand the botanical affinities of the Glossopteris flora it will be necessary to compare it somewhat closely with the Northern type of Permo-Carboniferous vegetation, and also with its immediate predecessor in geological time, the flora of the Upper Devonian and Lower Carboniferous rocks, which, as we have pointed out, was characterised by worldwide uniformity of distribution.

The plant-remains of the Upper Devonian period are unfortunately scanty, but within recent years our knowledge of these ancient types of vegetation has been considerably increased. It is interesting to note that beds of this age within the Arctic regions have been found to furnish more valuable material in this respect than those developed elsewhere. The Devonian floras of several Arctic lands are now known, thanks especially to the researches of Nathorst.[1] Among the other sediments of this age which have yielded plant-remains, the more important are those of Southern Ireland,[2] Belgium,[3] Austria,[4] Russia,[5] and Canada.[6]

In the Lower Carboniferous deposits of Europe and North America, plant-remains are more numerous and less fragmentary, and consequently the flora of this period is better known. It appears, however, to be essentially similar in type to that of the Upper Devonian rocks, and in all probability we may regard the Upper Devonian and Lower Carboniferous floras as constituting one great botanical epoch. Plant-remains belonging to the latter period

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1 Nathorst (94), (00), (02¹), (04).
2 See Kidston (86), pp. 228-236.
3 Crépin (74), (75).
4 Stur (81); Potonié & Bernard (04).
5 Schmalhausen (94).
6 Dawson (59), (71), (81).

have been described from Britain,[1] France,[2] Austria,[3] Russia,[4] China,[5] North America,[6] the Arctic regions,[7] and elsewhere.

So far we have mentioned only certain areas lying within the Northern Hemisphere. But it is particularly interesting to find that there is a considerable accumulation of evidence as to the existence of plants belonging to this same epoch in some of the provinces in which the Glossopteris flora flourished at a later period. Thus either Upper Devonian or Lower Carboniferous plant-remains have been described from New South Wales,[8] Victoria,[9] Queensland,[10] and Argentina.[11] With the exception of the last-mentioned, floras belonging to both these periods have been recorded. In India, unfortunately, the earliest plant-bearing sediments are those in which the Glossopteris flora is found, and in South Africa few, if any, plants are known from rocks of earlier age than Permo-Carboniferous. On the present evidence, however, the plant-remains of the Lower Carboniferous and Upper Devonian rocks of the other regions in which *Glossopteris* flourished at a later period appear to be generically, and often specifically, identical with those of the Northern Hemisphere.

We may briefly sum up the botanical affinities of the Lower Carboniferous and Upper Devonian flora as follows:—It consists, so far as is known, of representatives of six great groups. Of these the Equisetales, to which the modern Horsetails belong, are chiefly represented by an ancient and somewhat archaic type, *Archæocalamites*. The genus *Calamites* is also found, but comparatively rarely, in the Lower Carboniferous rocks. The great group of Lycopods, including the modern Club-mosses, is represented

1 Kidston (03).
2 Vaffier (01).
3 Stur (75).
4 Eichwald (60).
5 Schmalhausen (83^1), p. 433.
6 Dawson (73).
7 Nathorst (94).
8 Feistmantel (90); Etheridge (90^2); David & Pittman (93); Dun (99).
9 McCoy (74), Prod. i, iv.
10 Feistmantel (90), p. 54; Carruthers (72).
11 Szajnocha (91).

by two genera, *Lepidodendron* and *Bothrodendron*, while *Lepidophloios*, and to some extent also *Sigillaria*, appear in Lower Carboniferous times.

The Fern-like plants, whether they be true Ferns (Filicales), or fern-like Spermophytes (Pteridospermeæ), are numerous. Only one genus, *Adiantites*, a characteristic type, is at present known to have belonged to the latter group, while the true affinities of others, such as *Archæopteris*, *Cardiopteris*, *Rhacopteris*, and *Sphenopteris*, have yet to be ascertained. There is, however, evidence, from specimens in which the internal structure is preserved, that the Cycadofilices, of which some members are known to have possessed the seed-bearing habit (Pteridosperms), were not uncommon at this period.

There remain two important groups, the Sphenophyllales, of which the genus *Sphenophyllum* is the principal representative, and the Cordaitales, the latter of Gymnospermous affinity, both of which have been long extinct. They have been recorded from the Upper Devonian and the Lower Carboniferous rocks.

When we pass to the deposits laid down during Upper Carboniferous and Permian times, we find these same six groups still dominant types in the vegetation of that epoch, whether in the Northern or the Southern continent. Three new groups make their first appearance. These are the Cycadophyta, including the modern Cycads, a small tropical and sub-tropical family, now the sole survivors of what was once a great class of plants, the Coniferales, and the Ginkgoales, the last-named represented to-day by a single species, *Ginkgo biloba*. None of these new groups, however, became of real importance in the vegetation of the period which we are considering. They were entirely overshadowed, both in numbers and diversity, by the representatives of the six ancient types, which, as we have seen, were also dominant at an earlier epoch, although in the succeeding epochs of Mesozoic age they in their turn formed, with the ferns, the predominant types of vegetation.

Having briefly traced the broad features of the vegetation of the most ancient botanical epochs with which we are at all well acquainted, we may now pass on to compare and contrast the various elements of the two floras of Permo-Carboniferous times. The first point to be noticed is that the difference between them does not lie in the botanical types or classes of plants represented in each.

These are practically the same. Each flora consists of members of six ancient, and essentially dominant, Palæozoic groups, and of three newer, and subsidiary types of a Mesozoic facies.

EQUISETALES. In the northern type of flora, the Calamites are practically the sole representatives of this group. As already noticed, they make their first appearance during Lower Carboniferous times.

It is interesting to find that in either Lower Carboniferous or Upper Devonian rocks in New South Wales, Queensland, and Argentina, not only is *Archæocalamites* represented, as in Europe, but *Calamites* has also been recorded from the two former provinces. But in the rocks of Gondwanaland the genus *Calamites* is unknown. We have in its place two other representatives of the same group, *Schizoneura* and *Phyllotheca*, neither of which, however, is so well known, especially as regards its fructification, as the Calamites of the Northern Hemisphere.

Of the two, *Phyllotheca* is the more abundant and the more varied genus. It is represented by at least seven species, and has been found in all the four great provinces of Gondwanaland. None of the species, however, are very widely distributed. *P. australis*, probably the best known, is very similar to the Indian fossil *P. indica*. *P. deliquescens* is interesting as occurring not only in Australia, but possibly also in India and Natal, and, with certainty, in Northern Asia. The new species described here as *P. Etheridgei*, a very beautiful and distinct form, is recorded from Australia, where also the genus as a whole seems to have been much better represented than in any of the three other provinces. Thus, as at present known, *Phyllotheca* would seem to have been especially characteristic of Australia, where perhaps it may have originated, and subsequently spread rapidly to India and South Africa, and even beyond the boundaries of Gondwanaland. It is found in Asia Minor as early as Upper Carboniferous times, in Russia, Siberia, and the Altai during the Permian period, and in the Triasso-Rhætic epoch it still survived in New South Wales, Tasmania, and possibly in Queensland. It also occurs in the Rhætic rocks of Tonquin, and in the Lower Jurassic of Europe.

On the whole, while we may regard *Phyllotheca* as a successful type of plant life, it was probably also very closely related to *Calamites*. The fructification of the former is only known in detail

in the case of the species found in Asia Minor, and here we must confess that the resemblance to a Calamitean strobilus of the *Calamostachys* type is very striking. On the other hand, the cone of *P. deliquescens*, although not so well known, appears to be of a somewhat different nature. But so far as it is possible to form any opinion on the present evidence, *Phyllotheca* would seem to differ from *Calamites* chiefly in habit, and especially in possessing a well developed leaf-sheath. Even in the latter respect, as Mr. Seward[1] has pointed out, the vegetative differences are not so marked as have been supposed. Thus we may, I think, safely conclude that *Phyllotheca* was, on the whole, nearly related to *Calamites*, and that it in all probability sprang from the same ancient stock, of which *Archæocalamites* is the earliest known representative.

In *Schizoneura* we have a more distinct type, and one almost entirely confined to India during the Permo-Carboniferous period. In fact, this genus does not appear to have reached its maximum development and distribution until later times. Two species occur in India, of which *S. gondwanensis* is the more important. This plant is also known from Australia, where, however, it appears to be very rare. The genus is also probably represented in South Africa, but it is unknown, so far, from South America. We may regard *Schizoneura*, unlike *Phyllotheca*, as essentially of Indian origin, where it first appeared in the earlier *Glossopteris*-bearing series, and later spread to more distant regions. It probably did not reach New South Wales until near the close of the Permo-Carboniferous period. It is in Triasso-Rhætic times that the genus attained to its maximum distribution, when it survived not only in India (Panchet Series), but in South Africa (Stormberg Beds), and, further, had spread to Europe (Germany, Sweden, etc.), Persia, Tonquin, China, and elsewhere beyond the limits of Gondwanaland.

In vegetative habit, *Schizoneura* is more unlike *Calamites* than *Phyllotheca*. The details of the structure of the strobili, however, are unfortunately unknown, and until this information is available it is idle to speculate as to its precise affinities. The late period at which the genus appears to have attained to its maximum develop-

[1] Seward (98[1]), p. 289.

ment and distribution also points to an absence of near relationship to *Calamites*, although the recent discovery by Mr. Etheridge of impressions of the cones of *Schizoneura* has emphasised the conclusion that this plant is undoubtedly of Equisetalean affinities.

One other genus only is worthy of notice, represented by a single species from the earlier *Glossopteris*-bearing rocks of Australia, *Annularia* (?) *australis*. The affinities of this fossil are very problematical. No Calamitean stems are known in association with it, and in the absence of such it is unwise to insist too strongly on the occurrence of this type of foliage as evidence of the existence of *Calamites* in Gondwanaland, which the name given it by Feistmantel implies.

We may conclude that, on the whole, the Equisetalean members of the Glossopteris flora are distinct from those of the Northern Hemisphere, though in *Phyllotheca* we have a plant which probably is more closely related to *Calamites* than has been commonly supposed.

SPHENOPHYLLALES. In the Northern Hemisphere this class is chiefly represented by a single genus, *Sphenophyllum*, which is found in both the Devonian and the Lower and Upper Carboniferous rocks. It is a group which is rarely associated with the Glossopteris flora, only one restricted species occurring in India, and probably in South Africa. It is, however, specially interesting to notice that *Sphenophyllum speciosum* is essentially similar in habit to European members of the genus, although at one time the contrary was supposed. On the present evidence, it is impossible to imagine that this plant was at all a representative member of the Glossopteris flora, although the association of a characteristic northern type with the members of that flora is of great interest. It would appear possible that its presence in India may be accounted for by the existence of land connections between the Northern and Southern Permo-Carboniferous continents, a conclusion which the migration of the Glossopteris flora into Russia in Permian times supports (see Map, p. xix), and that in *Sphenophyllum speciosum* we have simply a member of the Northern flora which had penetrated into India. The existence of land connections[1] between Europe and South Africa, of which there is

[1] See Seward (03²), p. 833.

some evidence (see pp. xxviii, xxix), would also account for the presence of this genus in Natal.

It is significant that, although *Sphenophyllum* has been recorded from the Lower Carboniferous rocks of New South Wales, no trace of it has yet been recognised in association with the Glossopteris flora in Australia.

FILICALES and ?CYCADOFILICES. Fern-like plants form a very characteristic feature of the Glossopteris flora, but in no case is the fructification sufficiently well known to decide whether the plant in question is a true Fern or a seed-bearing, fern-like plant (Pteridosperm). Also, in the absence of petrified material, the existence of the Cycadofilices has yet to be demonstrated among this flora. The only comparison possible with the Northern Permo-Carboniferous vegetation is one based upon the vegetative habit, which is notorious as an unreliable guide to affinities. Still, it must be admitted that the fern-like plants of these two floras offer a somewhat sharp contrast, at least in habit, although types common to both occur. We may first consider the chief differences between them.

In *Glossopteris* and *Gangamopteris* we have fronds pre-eminently characteristic of the southern type of flora, and quite distinct in form and nervation from any known representative of the northern province. Both are not only diversified genera, especially *Glossopteris*, but flourished in great abundance numerically. *Glossopteris* is found almost everywhere within the boundaries of Gondwanaland, the most noteworthy exceptions being the colony of Victoria in Australia, and Brazil. It is interesting to find that where *Glossopteris* is absent, *Gangamopteris*, a plant probably very closely allied to the former genus, occurs, as in Victoria and Brazil. A large number of species of *Glossopteris* are known, at least thirteen, which in the details of their habit varied considerably. *Gangamopteris* was probably a smaller genus; four species and one variety being recognised here. It also appears to have been a somewhat earlier type, as it is of common occurrence in the oldest *Glossopteris*-bearing beds in India, in which *Glossopteris* itself is much less abundant. In New South Wales, however, it is unknown in the Muree Series. The genus apparently became extinct before *Glossopteris*, for it is not known to persist into the Triasso-Rhætic period, whereas *Glossopteris* is found in beds of that age in India, Tonquin,

and China. Both genera, however, migrated into Russia during Permian times, though they do not appear to have penetrated further into Europe at any period, despite assertions to the contrary in past times.

The fructification of *Gangamopteris* is entirely unknown, while that of *Glossopteris* is still too imperfectly understood to afford any evidence of value as to the botanical affinities of the genus. Both these fronds are, however, quite unlike any plant-remains known from the Northern Hemisphere.

In the genus *Neuropteridium*, we have an important type, probably not nearly connected with the European genus *Neuropteris*, as the name would seem to imply. In habit, at least, it would appear to be quite distinct. It is a frond which is never very abundant in Gondwanaland, but at the same time widely distributed. A single species is known from India, the Cape Colony, and South America, and thus affords an important aid in the correlation of these widely separated regions. Its botanical affinities are still obscure. It seems to have continued to flourish after the close of the Permo-Carboniferous period, when it had migrated into Europe, for fronds almost identical with the Indian species are found in the Bunter of the Vosges and elsewhere in the Trias of Europe.

In *Tæniopteris*, which is associated with the Glossopteris flora in India, and possibly also in Natal, we have a type of Fern-like plant which is not specially characteristic of the flora of Gondwanaland. The same genus also occurs, but sparingly, in the Carboniferous and Permian rocks of the Northern Hemisphere. It is essentially a Mesozoic type of frond, reaching its maximum development in Triassic and Jurassic times. In the Palæozoic beds of both Europe and North America, as of Gondwanaland, we seem to see the first incomings of races of great importance at later geological epochs, but not specially characteristic of the period at which they first appear. *Tæniopteris* is a case in point.

The genera *Sphenopteris* and *Pecopteris*, represented alike in both the northern and southern type of flora, are unworthy of detailed consideration here. They include many plants of very different geological ages, and no doubt of quite distinct relationships, which possess a particular type of frond-habit, and which, in the absence of a knowledge of their fructifications, we are unable, for the

present, to group more in accordance with their botanical relationships. It is interesting to find that, among the fronds hitherto assigned to the latter, some are here removed to the genus *Cladophlebis*, as having more in common with this Mesozoic type of Fern-like plant than with the Palæozoic. *Cladophlebis*, like *Tæniopteris*, is essentially a Mesozoic frond.

The Indian genus *Palæovittaria* is unlike in habit any member of the northern flora. The species assigned to *Merianopteris* and *Belemnopteris* are, however, too imperfectly known to warrant consideration in this connection. All three genera are of rare occurrence.

As compared with the northern flora, that of Gondwanaland is distinguished by the absence of such genera as *Alethopteris*, *Neuropteris*, *Odontopteris*, *Linopteris*, etc., as well as by a rarity of fronds of the true *Pecopteris* type.

On the whole the Fern-like plants of Gondwanaland stand out as remarkably distinct in habit from those of the northern flora, such features as are common, for instance the occurrence of *Tæniopteris*, being chiefly due to the gradual incoming of plants of a Mesozoic facies.

LYCOPODIALES. In striking contrast to the Fern-like plants, the Lycopods associated with the Glossopteris flora are all generically, and often specifically, identical with those of the northern flora. In India and Australia the group is entirely unrepresented, though at an earlier period both *Lepidodendron* and *Bothrodendron* flourished in New South Wales and Queensland, and the former also in Victoria. *Lepidodendron* also occurred in Argentina in Lower Carboniferous times. All the four great genera, *Lepidodendron*, *Lepidophloios*, *Sigillaria*, and *Bothrodendron*, have been found in association with the Glossopteris flora in either South Africa or South America, and these are the characteristic Lycopods of the Northern Hemisphere. The evidence of this remarkable association is one of the most striking results of recent research (see Historical Sketch). Bearing in mind the entire absence of this group from India and Australia, one is almost driven to the conclusion that in the Glossopteris flora proper the Lycopodean element was not represented. The occurrence of this group in South Africa and South America is probably best explained by the assumption that land connections existed in these regions between the Northern and

Southern Continents,[1] and that a migration of part of the northern flora into Gondwanaland took place. There are other reasons for such a conclusion. The existence of a typical Upper Carboniferous flora of the northern type at Tete[2] on the Zambesi, whereas *Glossopteris*-bearing rocks are known to stretch both to the north and south of that river, can only be explained by some such hypothesis. Further, the difficulty which might be raised as to why, on this assumption, the Lycopods are the only northern types found in the Transvaal in association with *Glossopteris*, is met by the fact that both Calamites, Cycadofilices, and Ferns of that type occur in the Tete basin, thus showing that other members of the northern flora were not absent from South Africa at this period. We may therefore conclude, at least provisionally, that the Lycopodean element was unrepresented in the Glossopteris flora proper. The absence of any new members of this group in either South Africa or South America is thus explained.

Cordaitales. In the Northern Hemisphere this group is represented by a single member, *Cordaites*, of great importance. In Gondwanaland we have the genus *Noeggerathiopsis*, whose precise affinities are still imperfectly understood. The leaves of *Noeggerathiopsis*, the only organs of that plant known, are very closely similar to those of *Cordaites*, and on the present imperfect evidence it would seem that the northern and southern members of this group were probably closely related. The occurrence of petrified wood, similar in structure to *Dadoxylon*, the stem of *Cordaites*, and of seeds of the type of *Cardiocarpus*, in association with the Glossopteris flora, tends to confirm this conclusion.

The genus *Noeggerathiopsis*, especially the species *N. Hislopi* (Bunb.), is widely distributed, being recorded from all the great provinces of Gondwanaland. Similar leaves also occur in the Triasso-Rhætic of Tonquin and China.

Cycadophyta. A critical examination of the Glossopteris flora has tended to show that only two representatives of this group are known, and one of these (*Cycadites*) is of a somewhat doubtful nature. The other is a *Pterophyllum*, not unlike the earlier Cycadean leaves of Europe, and very similar to some fronds from

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[1] See Seward ('03[2]), p. 833; Blanford, W. T. (90).

[2] Zeiller (83).

the Rhætic of Tonquin. In the floras of both the northern and southern Permo-Carboniferous continents, a few Cycads are found, which represent the gradual incomings of a great group, essentially of Mesozoic affinities, but in the latter flora the Cycadophyta are, if anything, less abundant than in the former. There is no good evidence to show that the leaves named *Pterophyllum burdwanense* and *Glossozamites Stoliczkanus* by Feistmantel, and *Sphenozamites multinervis* by Kurtz, are really referable to the Cycadophyta. The former is possibly a *Tæniopteris*, while the two latter are almost certainly leaves allied to *Noeggerathiopsis Hislopi*.

Ginkgoales (?). The genera somewhat doubtfully assigned to the Ginkgoales are rather more numerous than the Cycadophyta. Four species occur, belonging to three genera, of which two are only known so far from the Palæozoic rocks. One species, *Rhipidopsis ginkgoides*, is identical with a plant from the Permian of Russia, while another, *Psygmophyllum Kidstoni*, may be closely compared with members of the genus from the Carboniferous and Permian of Europe. In this group, again, we have another instance of the gradual incoming of a type of plant which reached its maximum during the Mesozoic period, though such members as are associated with the Glossopteris flora would appear to be early types hardly extending beyond the Palæozoic rocks.

Coniferales. The Coniferæ on the whole are few in number; the most interesting genus being *Voltzia*, which appears first in the Carboniferous of Europe, and is especially abundant in the Triasso-Rhætic rocks of the Northern Hemisphere. Of the other five genera recorded, three are doubtful attributions, and may be neglected here. *Araucarites*, so far only recorded from the Mesozoic rocks, has been found in India, but the exact horizon of the beds in which it occurs is uncertain. There remains *Cyclopitys*, only known elsewhere from the Permian of Europe. Although in *Voltzia* we have a type associated with the Glossopteris flora, which would appear to be chiefly of a Mesozoic facies, we notice that the Coniferæ, as a whole, are even less abundant than in the Northern flora, and that several of the representatives present are among the earliest to appear in the Northern Hemisphere.

Nearly all the fossil plants of the Glossopteris flora occur as casts or impressions, in which the anatomical structure is not

preserved. The petrifactions associated are comparatively few in number, and all are of the commoner type of petrified remains, namely, woody stems, often of considerable size. Wood of the *Dadoxylon* type, *Psaronius brasiliensis*, and *Lepidodendron Derbyi* are practically the only petrifactions which have been recorded from Gondwanaland, and consequently the anatomical structure of most of the members of the Glossopteris flora is at present entirely unknown. For this reason the botanical affinities of the flora are less clear than in the case of the Northern Permo-Carboniferous vegetation, where petrifactions of a special type, in which the structure of more delicate organs such as small stems, leaves, cones, seeds, etc., is preserved, are found on more than one horizon, and have greatly added to our knowledge on this subject.

We may sum up broadly the results of our critical survey of the botanical affinities of the Glossopteris flora, compared with that of the Northern Hemisphere, as follows:—

(1) The same great classes of plants are represented in each flora, with the exceptions noted below. In describing the Glossopteris flora, we have no new types of vegetation to distinguish.

(2) Of the six essentially Palæozoic classes in the Northern Hemisphere, two, the Lycopods and the Sphenophyllales, were probably only represented in the Glossopteris flora by migrations from the northern continent, and were not indigenous to Gondwanaland.

(3) One of the Palæozoic classes, Cordaitales, and all the three classes essentially of a Mesozoic facies, representing the incomings of the types of vegetation developed in the Mesozoic rocks, viz., the Cycadophyta, Ginkgoales, and Coniferales, may be regarded as being represented by almost identical members in both floras.

(4) The chief contrast between these two floras lies essentially in the Fern-like plants, whether they be true Ferns or Cycadofilices, and in the members of the class Equisetales, as well as in the absence of indigenous representatives of certain groups.

2. DISTRIBUTION IN SPACE.

The Glossopteris flora flourished in Permo-Carboniferous times in four great provinces of Gondwanaland, viz., India, Australasia, Southern Africa, and South America, and in certain regions outside these countries. In the succeeding Triasso-Rhætic period some members of the flora still survived, and these had an even wider distribution.

Europe: Russia.—The Glossopteris flora is found in the Permian beds of Soukhona and Petite Dwina.[1] The genus *Phyllotheca* is also recorded from Northern Russia.[2] Survivals of this flora are found in the Triasso-Rhætic rocks of Germany, Sweden, and elsewhere.

Asia: India.—The most important *Glossopteris*-bearing rocks in Asia are the Lower Gondwanas of India, of which the following are the chief divisions:—[3]

Lower Gondwanas.	Panchet Division.	Triasso-Rhætic, with survivals of the Glossopteris Flora.	
	Damuda Division.	Rániganj and Kamthi Series.	Permo-Carboniferous:—Glossopteris Flora.
		Barákar Series.	
	Talchir Division.	Karharbári Series.	
		Talchir Series.	
		Talchir Boulder-bed (Glacial).	

Members of the Glossopteris flora have also been recognised in Kashmir[4] (Permo-Carboniferous), Afghanistan and Persia[5] (Permo-Carboniferous), Asia Minor[6] (Upper Carboniferous), and the Altai and Siberia[7] (Permian). Survivals of the Glossopteris flora also occur in the Triasso-Rhætic rocks of India (Panchet division), Tonquin,[8] and China.[9]

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1 Amalitzky (97), (01).
2 Schmalhausen (79).
3 Feistmantel (79[2]).
4 Noetling (03); Seward & Woodward (05).
5 Griesbach (85).
6 Zeiller (99).
7 Schmalhausen (79), (83[1]); Zeiller (96[2]).
8 Zeiller (02[3]).
9 Krasser (01); Zeiller (00[2]).

Australasia: New South Wales.[1]

Wianamatta Series		Triasso-Rhætic, with a few survivals of the Glossopteris Flora.
Hawkesbury Series, with glacial deposits		
Newcastle Series ...	—Glossopteris Flora	Permo-Carboniferous.
Muree Series	Upper Marine Beds	
	"Lower Coal Measures"—Glossopteris Flora	
	Lower Marine Beds	
	Glacial deposits	

Victoria.[2]

Bacchus Marsh Sandstones ... Permo-Carboniferous:—Glossopteris Flora.
Bacchus Marsh Glacial deposits.

Queensland.[3]

Bowen River Series ... Permo-Carboniferous:—Glossopteris Flora.
Glacial deposits.

Western Australia.[4]—Members of the Glossopteris flora have been recognised in the Collie River coalfield, and at the Gascoyne River.

Tasmania.[5]

Mersey River Series ... Permo-Carboniferous:—Glossopteris Flora.
Glacial deposits.

Southern Africa[6]*: Cape Colony, Natal, Transvaal, Orange River Colony.*

KAROO SYSTEM.	Stormberg Series ... Triasso-Rhætic Flora.
	Beaufort Series ... Permo-Carboniferous:—Glossopteris Flora.
	Ecca Series ... Permo-Carboniferous:—Glossopteris Flora.
	Dwyka Conglomerate (Glacial).

The Glossopteris flora has also been recorded from Rhodesia,[7] and from German and Portuguese East Africa.[8]

South America: Brazil,[9] *Argentina.*[10]—A list of the plant-remains occurring in each of these regions of Gondwanaland will be found in the Historical Sketch.

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[1] Feistmantel (90).
[2] McCoy (74), (98); Feistmantel (90).
[3] Carruthers (72), (89); Feistmantel (90); Jack & Etheridge (92); Shirley (98), (02).
[4] Etheridge, sen. (93); Etheridge, jun., & David (94).
[5] Johnston (86), (88), etc.; Feistmantel (90).
[6] Feistmantel (89); Zeiller (96^1); Seward (97^1); Etheridge (01).
[7] Arber (03).
[8] Potonié (99), (00).
[9] Carruthers (69); Zeiller (95^2).
[10] Kurtz (94^2); Bodenbender (95), (96).

DISTRIBUTION OF THE GLOSSOPTERIS FLORA.

List of Species.	Permo-Carboniferous.															Triasso-Rhætic.		
		India.		N.S. Wales.														
	Europe: Russia.	Talchir Division.	Damuda Division.	Muree Series.	Newcastle Series.	Victoria.	Queensland.	Tasmania.	Cape Colony.	Natal.	Orange River Colony and Transvaal.	Rhodesia.	German and Portuguese East Africa	Brazil.	Argentina.	India: Panchet Division.	Tonquin.	China.
Reinschia australis	...	...	...	...	X	...	...	...	...	...	...	...	...	...	...	...	...	...
Pila australis	...	...	...	...	X	...	...	...	...	...	...	...	...	...	...	...	...	...
Schizoneura gondwanensis	...	X	X	...	X	...	...	...	...	...	...	...	...	...	...	X	...	...
S. Wardi	...	X	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
S. (?) *africana*	...	...	...	...	...	...	...	...	X	...	...	...	...	...	...	...	...	...
[*Actinopteris*] *bengalensis*	...	...	X	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Phyllotheca australis	...	...	...	X	X	X	X	X	...	...	...	...	...	...	...	...	...	...
P. indica	...	...	X	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
P. deliquescens	...	...	?	...	X	...	...	...	...	?	...	...	...	...	...	...	...	...
P. Griesbachi	...	...	X	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
P. robusta	...	...	?	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
P. Etheridgei	...	...	...	...	X	...	...	...	...	...	...	...	...	...	...	...	...	...
P. Zeilleri	...	...	...	...	...	...	...	...	...	X	...	...	...	...	...	...	...	...
P. sp.	...	...	...	...	...	...	...	...	X	...	...	...	...	...	X	...	...	...
[*Annularia?*] *australis*	...	...	...	X	...	...	...	...	...	...	...	...	...	...	...	...	...	...
[*Equisetites?*] *Morenianus*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	X	...	...	...
Sphenophyllum speciosum	...	...	X	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
S. sp.	...	...	...	...	...	...	...	...	...	X	...	...	...	...	...	...	...	...
Glossopteris Browniana	...	...	X	X	X	...	X	X	X	X	X	?	X	...	...	...	X	...
G. indica	X	X	X	?	X	...	X	X	X	...	X	...	X	...	X	X	X	X
G. angustifolia	X	...	X	...	...	...	...	...	X	X	X	...	X	...	...	...	X	...
G. stricta	X	...	X	...	...	...	...	...	?	...	...	...	...	...	...	...	...	...
G. ampla	...	X	X	...	X	...	X	X	X	X	...	?	...	...	...	...	...	...
G. retifera	...	...	X	...	...	...	...	...	X	X	X	...	...	...	X	...	...	...

Glossopteris conspicua ...	...	...	x	...	...	...	...	...	...	...	x	...	...	...	...	...	...	...
G. formosa ...	...	...	x	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
G. tortuosa ...	...	...	x	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
G. divergens ...	...	...	x	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
G. decipiens ...	...	x	...	?	...	...	...	...	...	...	...	...	...	...	...	...	...	...
G. longicaulis ...	...	x	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
G. orbicularis ...	...	...	x	...	?	...	...	...	...	...	...	...	...	...	...	...	...	...
Vertebraria indica ...	?	x	x	...	x	...	...	x	...	...	x	...	?	?	...	...	...	...
Gangamopteris cyclopteroides ...	x	x	x	...	x	x	...	x	...	...	x	...	...	x	x	...	...	...
G. cyclopteroides, var. *major* ...	x	x	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
G. angustifolia ...	...	x	...	...	x	x	...	x	...	...	...	...	...	...	...	...	...	...
G. Whittiana ...	...	...	x	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
G. (?) *buriadica* ...	...	x	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Neuropteridium validum ...	...	x	...	...	...	...	...	...	x	...	...	...	...	x	x	...	...	...
Tæniopteris danæoides ...	...	...	x	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
T. Feddeni ...	...	...	x	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
T. spathulata ...	...	...	...	...	...	...	...	...	...	x	...	...	...	...	...	...	x	...
T. cf. *M'Clellandi* ...	...	...	?	...	...	...	...	...	...	...	...	...	...	...	...	...	x	...
T. sp. ...	...	...	...	...	...	x	...	...	...	...	...	...	...	...	...	...	...	...
Palæovittaria Kurzi ...	...	...	x	...	...	...	...	...	...	...	...	...	...	...	...	...	x	...
Sphenopteris polymorpha ...	...	...	x	...	x	...	...	...	...	...	...	...	...	...	...	...	...	...
S. Hughesi ...	...	...	x	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
S. lobifolia ...	...	...	...	...	x	...	x	x	...	...	...	...	...	...	...	...	...	...
S. alata ...	...	...	...	...	x	...	...	...	...	...	...	...	...	...	...	...	...	...
S. sp. ...	...	...	x	...	...	...	...	...	x	...	x	...	...	...	...	...	...	...
Pecopteris phegopteroides ...	...	...	x	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cladophlebis Roylei ...	...	...	x	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
C. sp. ...	...	...	x	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Merianopteris major ...	...	...	x	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Belemnopteris Wood-Masoniana	...	...	x	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Psaronius brasiliensis ...	...	...	...	...	...	...	...	...	...	...	...	...	...	x	...	...	...	...
[*Caulopteris* ?] *Adamsi* ...	...	...	...	...	x	...	...	...	...	...	...	...	...	...	...	...	...	...
Lepidodendron Pedroanum ...	...	...	...	...	...	...	...	...	...	...	...	...	...	x	...	...	...	...
L. Derbyi ...	...	...	...	...	...	...	...	...	...	...	...	...	...	x	...	...	...	...
Lepidophloios laricinus ...	...	...	...	...	...	...	...	...	...	...	...	...	...	x	...	...	...	...
Bothrodendron Leslii ...	...	...	...	...	...	...	...	...	...	...	x	...	...	...	...	...	...	...
Sigillaria Brardi ...	...	...	...	...	...	...	...	...	...	...	x	...	...	...	...	...	...	...
Noeggerathiopsis Hislopi ...	...	x	x	x	x	...	...	x	x	...	x	...	...	...	x	...	?	?
N. Whittiana ...	...	x	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

List of Species.	Permo-Carboniferous.															Triasso-Rhætic.		
		India.		N.S. Wales.														
	Europe: Russia.	Talchir Division.	Damuda Division.	Muree Series.	Newcastle Series.	Victoria.	Queensland.	Tasmania.	Cape Colony.	Natal.	Orange River Colony and Transvaal.	Rhodesia.	German and Portuguese East Africa.	Brazil.	Argentina.	India: Panchet Division.	Tonquin.	China.
Noeggerathiopsis (?) *Stoliczkana*	...	x	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
[*N.* ?] *lacerata*	...	x	x	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Dadoxylon australe	...	...	...	...	x	...	...	...	...	...	...	...	...	...	...	...	...	...
D. Pedroi	...	...	...	...	...	...	...	...	...	...	...	...	...	x	...	...	...	...
D. Maitlandi	...	...	...	...	...	...	x	...	...	...	...	...	...	...	...	...	...	...
D. Binneyi	...	...	...	...	...	...	x	...	...	...	...	...	...	...	...	...	...	...
D. Williamsoni	...	...	...	...	...		x	...	...	...	...	...	...	...	...	...	...	...
D. brisbanense	...	...	...	...	...	...	x	...	...	...	...	...	...	...	...	...	...	...
D. sp.	...	...	...	...	x	...	x	...	...	...	...	...	...	...	...	...	...	...
Cardiocarpus indicus	...	x	...	...	...		...	...	...	...	...	...	...	...	...	...	...	...
C. (?) *Milleri*	...	x	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
C. sp.	...	x	x	...	x	...	?	x	...	...	x	...	...	...	...	...	...	...
Pterophyllum (*Anomozamites*) *Balli*	...	...	x	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cycadites (?), sp.	...	x	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Rhipidopsis ginkgoides	...	...	x	...	...	...	...	...	...	...	...	...	...	...	x	...	...	...
R. densinervis	...	...	x	...	...	...	...	...	...	...	...	...	...	...	x	...	...	...
Psygmophyllum Kidstoni ..	...	...	...	...	...	...	...	...	...	...	x	...	...	...	...	...	...	...
Ottokaria bengalensis	...	x	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Voltzia heterophylla	?	x	x	...	...	...	...	...	...	...	...	...	?	...	...	...	...	...
Albertia (?), sp.	...	x	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cyclopitys dichotoma	...	...	x	...	...	...	...	...	...	...	...	...	...	...	x	...	...	...
Brachyphyllum (?) *australe* ...	...	...	...	...	x	...	...	...	...	...	...	...	...	...	...	...	...	...
Araucarites Oldhami	...	...	?	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
[*Walchia*], sp.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	x	...	...	...
Conites, sp.	...	...	...	...	...	...	...	...	...	...	x	...	...	...	...	...	...	...
Dictyopteridium sporiferum ...	...	x	x	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

TABLE OF CORRELATION OF THE PRINCIPAL *GLOSSOPTERIS*-BEARING ROCKS.

	India.	New South Wales.	Victoria.	Queensland.	Tasmania.	Cape Colony, Natal, Transvaal, Orange River Colony.	Argentina.
Triasso-Rhætic.	Panchet Division of Lower Gondwanas (Triassic flora with survivals of the Glossopteris Flora).	Wianamatta Series and Hawkesbury Series, with Boulder Beds (Triassic flora with a few survivals of the Glossopteris Flora).	?	?	"Up. Coal Meas.," in part (Triassic flora with survivals of the Glossopteris Flora).	Stormberg Series (Rhætic flora without survivals of the Glossopteris Flora).	Beds of Cacheuta, Mendoza; El Transito, Rio Atuel; Mareyes, Sierra de la Huerta (Rhætic flora without survivals of the Glossopteris Flora).
Permo-Carboniferous.	Damuda Division: Rániganj Group, Barákar Group (Glossopteris Flora). Talchir Division: Karharbári Group, Talchir Group (Glossopteris Flora). Talchir Boulder Beds.	Newcastle Series (Glossopteris Flora). Muree Series: Up. Marine Beds, "L. Coal Meas." (Glossopteris Flora), L. Marine Beds. Boulder Beds.	Bacchus Marsh Sandstones (Glossopteris Flora). Bacchus Marsh Conglomerates.	Bowen River Series (Glossopteris Flora).	Mersey River Series "L. Coal Meas." (Glossopteris Flora).	Beaufort Series (Glossopteris Flora). Ecca Series (Glossopteris Flora). Dwyka Conglomerate.	Beds of Trapiche, Rioja; Sierra de S. Luis; Sierra de los Llanos; Sierra de la Rioja (Glossopteris Flora). Boulder Beds.
Lower Carboniferous and Devonian.		Lepidodendron Beds of Smith's Creek, etc. (Lower Carboniferous flora). Goonoo Goonoo Beds (Upper Devonian flora).	Avon Sandstone (L. Carboniferous flora). Iguana Creek Beds (Upper Devonian flora).	Bobuntungen Beds, Drummond Range Sandstones (Lower Carboniferous flora). Mt. Wyatt Beds (Upper Devonian flora).	?	Witteburg Series (few plants). Bokkeveld Series (no plants).	Beds of Retamito, S. Juan (Lower Carboniferous Flora).

3. AGE AND DISTRIBUTION IN TIME.

The precise age of the Glossopteris flora has been the subject of much discussion in past times. During the latter half of the last century, a prolonged controversy arose as to whether its affinities should be regarded as Mesozoic or Palæozoic. Owing to the fact that the flora of Gondwanaland differs so remarkably from the Upper Palæozoic vegetation of Europe, most of the earlier authorities, with a few noteworthy exceptions, decided that it flourished during the Mesozoic period, in all probability in Jurassic times. Among those who held this view were McCoy,[1] de Zigno,[2] Schimper,[3] and, to some extent, Bunbury.[4] Feistmantel[5] especially was the great exponent of this doctrine, and he endeavoured to prove its correctness on many occasions. It is to the work of the Rev. W. B. Clarke,[6] the "Father of Australian Geology," and to the researches of T.[7] and R. D. Oldham[8] and the brothers H. F.[9] and W. T. Blanford[10] in India, that the merit of exposing the fallacy of this conclusion is due. It is now almost universally accepted that the Glossopteris flora flourished at a period homotaxial with the deposition of the Upper Carboniferous and Permian deposits of Europe and North America. Even Feistmantel,[11] in his last great work on this flora, published in 1890, accepted this conclusion, at least so far as the age of the Australian beds was concerned, though he still adhered to his former opinion with regard to the Damuda Series of India.

It has so far proved to be impossible to distinguish clearly between the flora of the lower and upper series of *Glossopteris*-bearing beds in India and other countries (see Table, p. xxxvii); consequently this epoch is spoken of as Permo-Carboniferous. There can be no doubt, in the light of our present knowledge,

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[1] McCoy (47).
[2] Zigno (60).
[3] Schimper (69).
[4] Bunbury (61).
[5] Feistmantel (76^1), (79^2), and other papers.
[6] Clarke (48), (61), (78).
[7] T. Oldham (60), (65).
[8] R. D. Oldham (86).
[9] H. F. Blanford (75).
[10] W. T. Blanford (76), (81), (86).
[11] Feistmantel (90), pp. 182–3.

that it was during this period that the Glossopteris flora, as a whole, attained to its maximum development and differentiation, though many of the typical genera still survived, as we shall see, in early Mesozoic times.

We may briefly examine the evidence as to the geological age of the rocks of Gondwanaland, so far as it is based on the occurrence of plant-bearing deposits.

Between the years 1845 and 1886, the *Glossopteris*-bearing sequence in India and Australia had received considerable attention, but the precise age of the beds was much in dispute. The first real evidence on this point was obtained from Australia. The earlier *Glossopteris*-bearing rocks in New South Wales—the Muree Series, known locally as the "Lower Coal Measures"—are underlain and overlain by marine beds containing a rich invertebrate fauna. The mollusca collected from these rocks were worked out in 1876–7 by de Koninck, who showed that they were largely identical with those of the Carboniferous deposits of Europe. Hence the *Glossopteris*-bearing sequence is, in part at least, of Carboniferous age.

During the period referred to above, the examination of these deposits had resulted in the discovery of a remarkable series of beds of glacial origin in India and Australia,[1] underlying the earlier *Glossopteris*-bearing sediments. The Talchir boulder beds in India, the conglomerates at the base of the Muree Series in New South Wales, the Bacchus Marsh boulder beds in Victoria, and similar accumulations elsewhere in Australia [2] are cases in point.

It had thus become clear that there was evidence of the existence of widespread glacial conditions immediately antecedent to the first appearance of *Glossopteris* and its allies, and this discovery helped materially in the correlation of the Indian and Australian deposits.[3] In 1886, Waagen [4] showed that deposits, similar in character to the Talchir boulder beds, occur in the Salt Range of Northern India, and are overlain by sediments, containing *Conularia* and other typical members of the European Carboniferous fauna. This

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1 W. T. Blanford (84), (86).
2 See David (96).
3 H. F. Blanford (75); W. T. Blanford (86); R. D. Oldham (86).
4 Waagen (86); W. T. Blanford (86).

important discovery was the first direct evidence to be gained from India bearing on the age of the Glossopteris flora. In the previous year, Griesbach[1] had shown that *Vertebraria* occurs in beds which overlie similar glacial deposits in Afghanistan.

Still more recently, the existence of a well-marked Glacial period at the beginning of Permo-Carboniferous times has received yet wider confirmation. The Dwyka conglomerate of South Africa is of glacial origin, and occupies a similar position with regard to the *Glossopteris*-bearing beds of that province as in India and Australia. Further, in 1888, Derby[2] showed that glacial deposits belonging to the same period are also developed in Brazil.

Within the last two years, Noetling[3] has found *Gangamopteris* in the Salt Range of Kashmir in beds below those containing Permian invertebrata.

Amalitzky[4] has also discovered the Glossopteris flora in Russia on a horizon intermediate between a plant-bearing series of Lower Permian age and deposits containing Upper Zechstein mollusca.

Further, there is the botanical evidence of the Glossopteris flora itself. The representatives of two groups associated with that flora, the Lycopods and the Sphenophyllales, are generically, and sometimes even specifically, identical with those of the northern type of vegetation. Among the earlier types of a Mesozoic facies, such as *Tæniopteris*, *Voltzia*, and *Rhipidopsis*, which begin to come in during Permo-Carboniferous times in both the northern and southern floras, there is also generic identity. Also the essentially Palæozoic types, which at this period were dominant elements in the flora, all belong, so far as their botanical affinities are known, to the same great classes of plants as the members of the flora of the Northern Hemisphere.

At the close of Permo-Carboniferous times, a change took place in the flora of Gondwanaland. It is of great interest to find that we have an almost *continuous* succession of plant-bearing sediments in more than one province of this continental region, in part of Palæozoic, and in part of Mesozoic age. This is the case in India

[1] Griesbach (85), p. 62.
[2] See W. T. Blanford (95), (96).
[3] Noetling (03); Seward & Woodward (05).
[4] Amalitzky (97), (01).

and New South Wales, and possibly also in South Africa. We are able therefore to trace to some extent the fate of the various elements of the Palæozoic flora as recorded in rocks of Triasso-Rhætic age. We find that by this time some members of the flora had become extinct, though representatives of perhaps the majority of the more important genera still survived. These, in some cases, inhabited regions more or less conterminous with the pre-existing Palæozoic continent, but the more marked characteristic of this period is the evidence of a widespread migration[1] of many of the Palæozoic genera far beyond the boundaries of Gondwanaland.

This conclusion is not based on the distribution of such elements of a Mesozoic facies as are present in the Glossopteris flora, as well as in the northern type of Palæozoic vegetation. We recognise such elements in the genus *Tæniopteris* among Fern-like plants, the Cycadophyta, the Ginkgoales, and the Coniferæ, such as *Voltzia*, associated in India and elsewhere with *Glossopteris* and its allies. The presence of these types, in common with the marked migration in early Mesozoic times of certain genera essentially of a Palæozoic facies, serves but to confirm the conclusion that the change in the vegetation from a Palæozoic to a Mesozoic facies was of an extremely gradual nature. In the Triassic rocks (excluding the Rhætic) we have a flora which is essentially a Transition flora, in which the older Palæozoic types one by one die out, and gradually give place to newer types of a Mesozoic facies, whose first incomings, as in the case of the above-mentioned families, we can trace back as far as the Carboniferous rocks.

But when we turn to the truly Palæozoic genera, such as *Schizoneura*, *Phyllotheca*, and *Neuropteridium*, we find in several cases that they have spread as far as Western Europe in Triassic times. It is a moot point at present how far the presence of such survivals of the Glossopteris flora may be regarded as dominant members of the flora of the Triassic (excluding the Rhætic) period. The difficulty arises from the fact that the vegetation of the Triassic rocks of Europe is still very imperfectly known. But whether we regard such survivals as characteristic and dominant elements in the flora of that Transition period or not, there can be no doubt

[1] Seward (03^2), p. 835.

that they did not play such a part in the true Mesozoic floras. The Mesozoic facies of vegetation is first found fully developed in Rhætic times, and persisted in the Jurassic and Wealden. It is especially characterised by a general absence of the older Palæozoic types; such as existed being numerically inferior and quite overshadowed by the development of new types of plant life. It is true that in Tonquin, China, Europe, and elsewhere a few survivals, such as *Schizoneura*, *Glossopteris*, etc., have been found associated with the Rhætic flora, but these, as recent research has shown, are all of secondary importance as compared with the other elements of the flora. Similarly, *Phyllotheca* survived as late as the Jurassic period in Italy, whereas almost all the other elements of the Jurassic flora are essentially of a Mesozoic type.

It has been assumed by many palæobotanists in the past that the Mesozoic facies of the Glossopteris flora is beyond dispute, since several of its most characteristic members are found in the Trias, and even extend to the Rhætic. I have endeavoured to show that this conclusion is incorrect. Further evidence may be found in the general absence of Mesozoic types from the rocks of Gondwanaland, with the exception of a few Ferns, Cycads, Ginkgoales, and Coniferæ, which both in the Northern and the Southern Hemispheres are among the earliest arrivals of a Mesozoic facies. We find practically no representatives of such typical Mesozoic genera as *Equisetites*, *Clathropteris*, *Laccopteris*, *Dictyophyllum*, *Sagenopteris*, *Williamsonia*, *Otozamites*, *Podozamites*, *Nilssonia*, *Ginkgo*, and *Baiera*, among many others which might be mentioned as having a worldwide distribution.

In the past, the evidence of the Mesozoic facies of this flora has been based partly on inaccurate generic determinations. I have already noticed (p. xxx) some of these in relation to the Cycads, a group which in reality is very scantily represented in the Glossopteris flora. Similarly, the name *Glossopteris* has been applied by some of the older authorities on palæobotany to Mesozoic plants which do not belong to that genus.[1] The converse has also occurred in the case of *Sagenopteris*, a typical frond of a Mesozoic facies, which has been recorded from

[1] Schimper (69), vol. i, pp. 641–2.

Gondwanaland by Feistmantel, but which in reality is entirely unrepresented in that flora. The attributions to the genera *Actinopteris* and *Asplenium* are other cases in point.

With regard to the nature of the climate of Gondwanaland there is no evidence to be gained from the plant-remains as they are at present known. This is particularly unfortunate, since it would seem to be impossible to account for the differences between the northern and southern floras by the mere fact of isolation alone. It would appear that climate as well as isolation must have had a determining influence on the distribution of Permo-Carboniferous vegetation.[1] Probably the existence of widespread glacial conditions immediately preceding the deposition of the earlier *Glossopteris*-bearing sediments had a marked influence in this connection.[2] Dr. Blanford[3] has suggested there is "some evidence in favour of the view that the transfer of the southern plants to the Northern Hemisphere was caused by a period of low temperature that drove a southern temperate flora northward to the equator." He adds that "it is highly probable that many other forms of terrestrial life besides the Mesozoic flora originated in the Southern Hemisphere; and unless a very considerable area of what is now deep ocean was occupied by land in Mesozoic and Palæozoic times, a change in favour of which there appears but slight evidence, it is far from improbable that the Antarctic continent was the original area of development."

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[1] W. T. Blanford (90), p. 96.

[2] See Seward (03^2), pp. 834–5 ; H. F. Blanford (75), pp. 534, 540.

[3] W. T. Blanford (90), pp. 105–6.

HISTORICAL SKETCH.

The various regions of the world, from which members of the Glossopteris flora have been recorded, are so scattered that it will perhaps be most convenient, in a brief historical sketch of the rise and progress of our knowledge of this flora, to consider each area separately.

I. Southern Asia.

(*a*) *India.*

The first Indian specimens of *Glossopteris*, obtained from "Rana-Gunge, near Rajemahl," were described by Brongniart[1] in 1828. At the same time another important genus, afterwards known as *Schizoneura*, was founded.[2]

Glossopteris Browniana, sp. nov.
Zeugophyllites = ? *Schizoneura*.[3]
Convallarites = *Schizoneura*.

In 1830 Brongniart,[4] in his "Histoire des Végétaux fossiles," described and figured two Indian species of *Glossopteris*.

Glossopteris Browniana, var. *indica* = *G. indica*, Schimper.
G. angustifolia, sp. nov.

Royle,[5] in the first part of his "Illustrations of the Botany of the Himalayan Mountains," published in 1833, figured several important types from the Bardwán Coalfield (Raniganj Group, Damuda Series) of India. These specimens, now in the British Museum, were re-examined by the present author in 1901,[6] and are also described in this volume.

Trizygia speciosa, sp. nov. = *Sphenophyllum speciosum* (Royle).
Vertebraria indica, sp. nov.
Glossopteris danæoides, sp. nov. = *Tæniopteris danæoides* (Royle).
Pecopteris Lindleyana, sp. nov. = *Cladophlebis Roylei*, Arber.
Pustularia calderiana, sp. nov. = *Nomen nudum*.

[1] Brongniart (28^1), p. 54.
[2] Brongniart (28^1), pp. 121, 128, 175.
[3] Arber (02^1), pp. 18, 19.
[4] Brongniart (28^2), pp. 223–4, pl. lxii (pars); pl. lxiii, fig. 1.
[5] Royle (33).
[6] Arber (01).

In 1836, Göppert[1] described and figured *Glossopteris* in his work "Die fossilen Farnkräuter."

In 1850, M'Clelland[2] figured several new specimens from the Bardwán Coalfield, India, in addition to examples of three species which had been previously described. His drawings, however, were so carelessly executed, and the descriptions of the specimens so imperfect, that it is practically impossible to recognise any of M'Clelland's species, with the exception of *Tæniopteris danæoides*.

Zamia burdwanensis, sp. nov. = ? *Tæniopteris*, sp.[3]
Sphenophyllum fasciculatum, sp. nov. = ?
Poacites muricata, sp. nov. = ?
P. minor, sp. nov. = ?
Glossopteris acaulis, sp. nov. = *Glossopteris*, sp.
G. frondosa, sp. nov. = *Glossopteris*, sp.
G. reticulata, sp. nov. = *Glossopteris*, sp.
Tæniopteris danæoides (Royle).
Pecopteris affinis, sp. nov. = ? *Sphenopteris polymorpha*, Feist.[4]
Fucoides venosus, sp. nov. = ? *Glossopteris*, sp.

Sir Charles Bunbury,[5] in 1861, described a number of fossil plants from Nágpur in Central India, of which several were new species. These important type-specimens are now in the Museum of the Geological Society of London.

Glossopteris Browniana, var. *indica*, Brong. = *G. indica*, Schimper.
G. Browniana, var. *australasica*, Brong. = *G. Browniana*, Brong.
G. musæfolia, sp. nov. = *G. ampla*, Dana.
G. leptoneura, sp. nov. = *G. angustifolia*, Brong.
G. stricta, sp. nov.
Pecopteris (?) = *Sphenopteris polymorpha*, Feist.
Cladophlebis = *Sphenopteris polymorpha*, Feist. (?).
Tæniopteris danæoides, M'Clell. (?) = ? *T.* cf. *M'Clellandi* (Old. & Morr.).
Filicites = ? *Glossopteris*, sp.
Filicites (qu. *Glossopteris*, sp. ?) = *Glossopteris*, sp.
Noeggerathia? (*Cyclopteris*?) *Hislopii*, sp. nov. = *Noeggerathiopsis Hislopi* (Bunb.).
Phyllotheca indica, sp. nov.
Vertebraria (?).
Knorria? (conifer ?) = ? *Bothrodendron*, sp.
Yuccites (?) = ?

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[1] Göppert (36), p. 346, pl. xxi, figs. 9, 10.
[2] M'Clelland (50), pp. 53–6, pls. xiv–xvii. [3] See p. 122.
[4] See Feistmantel (80), p. 77; and p. 132 of the present work.
[5] Bunbury (61).

Feistmantel,[1] in 1876, described the following new species from the Damuda formation :—

Schizoneura gondwanensis, sp. nov.
Gangamopteris cyclopteroides, sp. nov.
Sagenopteris, sp. = *Glossopteris*, sp.
Neuropteris valida, sp. nov. = *Neuropteridium validum*, Feist.
Actinopteris bengalensis, sp. nov. = [*A.*] *bengalensis*, Feist.

In the same year Feistmantel[2] published an important paper in the Journal of the Royal Asiatic Society of Bengal, in which the following additions to the Glossopteris flora were described :—

Sphenopteris polymorpha, sp. nov.
Alethopteris phegopteroides, sp. nov. = *Pecopteris phegopteroides* (Feist.).
Palæovittaria Kurzi, sp. nov.
Belemnopteris Wood-Masoniana, sp. nov.
Gangamopteris Whittiana, sp. nov.
Glossopteris communis, sp. nov. = *G. indica*, Schimper.
Sagenopteris polyphylla, sp. nov. = *Glossopteris retifera*, Feist.

In 1877 the following species were added :—[3]

Glossopteris stenoneura, sp. nov.[3] = *G. indica*, Schimper.
Rhizomopteris Balli, sp. nov.

Feistmantel,[4] in 1879, published the first part of his great work on the Fossil Flora of the Lower Gondwanas, which included numerous figures of almost all of the Permo-Carboniferous plants known from India. The first section, together with a supplement, was devoted to the lower series of *Glossopteris*-bearing rocks, known as the Talchir-Karharbári beds. The following species were described :—

Schizoneura cf. *Meriani* (Brong.) = *Schizoneura*, sp. (?).
S. gondwanensis, Feist.
Vertebraria indica, Royle.
Neuropteris valida, Feist. = *Neuropteridium validum*, Feist.
Glossopteris communis, Feist. = *G. indica*, Schimper.
G. damudica, sp. nov. = *G. ampla*, Dana.
G decipiens, sp. nov.
Gangamopteris (?) *buriadica*, sp. nov.
G. major, sp. nov. = *G. cyclopteroides*, var. *major*, Feist.
G. cf. *angustifolia*, McCoy.
G. cyclopteroides, Feist.

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[1] Feistmantel (76¹).
[2] Feistmantel (76²).
[3] Feistmantel (77¹), p. 74.
[4] Feistmantel (79¹).

Gangamopteris cyclopteroides, var. *subauriculata*, Feist. = *G. cyclopteroides*, Feist.
G. cyclopteroides, var. *areolata*, Feist. = *G. cyclopteroides*, Feist.
G. cyclopteroides, var. *attenuata*, Feist. = *G. cyclopteroides*, Feist.
Sagenopteris (?) *Stoliczkana*, sp. nov. = ? *Glossopteris decipiens*, Feist.
Glossozamites Stoliczkanus, Feist. = *Noeggerathiopsis* (?) *Stoliczkana* (Feist.).
Noeggerathiopsis Hislopi (Bunb.).
N. Hislopi, var. *subrhomboidalis*, Feist. = *N. Hislopi* (Bunb.).
Euryphyllum Whittianum, sp. nov. = *Noeggerathiopsis Whittiana* (Feist.).
Voltzia heterophylla, Brong.
Samaropsis cf. *parvula*, Heer.
Carpolithes Milleri, sp. nov. = *Cardiocarpus* (?) *Milleri* (Feist.).

In the second and third parts of the Lower Gondwana flora, published in 1880–1, Feistmantel dealt with the fossil plants from the Damuda-Panchet divisions. The following Permo-Carboniferous species are figured:—[1]

Schizoneura gondwanensis, Feist.
S. cf. *Meriani* (Brong.) = *Schizoneura*, sp. (?).
Phyllotheca indica, Bunb.
P. robusta, sp. nov.
Trizygia speciosa, Royle = *Sphenophyllum speciosum* (Royle).
Vertebraria indica, Royle.
Cyathea cf. *Tchihatcheffi*, Schmal. = cf. *Sphenopteris polymorpha*, Feist.
Sphenopteris polymorpha, Feist.
Dicksonia Hughesi, Feist. = *Sphenopteris Hughesi* (Feist.).
Asplenium whitbyense, Goepp. = *Cladophlebis*, sp.
Alethopteris Lindleyana, Royle = *Cladophlebis Roylei*, Arber.
A. phegopteroides, Feist. = *Pecopteris phegopteroides* (Feist).
Merianopteris major, sp. nov.
Macrotæniopteris danæoides (Royle) = *Tæniopteris danæoides* (Royle).
M. Feddeni, Feist. = *Tæniopteris Feddeni* (Feist.).
Palæovittaria Kurzi, Feist.
Angiopteridium cf. *M'Clellandi* (Old. & Morr.) = *Tæniopteris* cf. *M'Clellandi* (Old. & Morr.).
A. infarctum, sp. nov. = cf. *Tæniopteris M'Clellandi* (Old. & Morr.).
Glossopteris communis, Feist. = *G. indica*, Schimper.
G. communis, var. *stenoneura*, Feist. = *G. indica*, Schimper.
G. intermittens, sp. nov. = *G. Browniana*, Brong.
G. stricta, Bunb.
G. musæfolia, Bunb. = *G. ampla*, Dana.
G. indica, Schimper.
G. Browniana, Brong.
G. retifera, sp. nov.
G. conspicua, sp. nov.

[1] Feistmantel (80).

Glossopteris divergens, sp. nov.
G. damudica, sp. nov. = *G. ampla*, Dana.
G. angustifolia, Brong.
G. leptoneura, Bunb. = *G. angustifolia*, Brong.
G. formosa, sp. nov.
G. orbicularis, sp. nov.
G. decipiens, Feist.
Gangamopteris anthrophyoides, sp. nov. = ?
G. Whittiana, Feist.
G. Hughesi, Feist. = *G. cyclopteroides*, Feist.
G. cyclopteroides, Feist.
G. cyclopteroides, var. *subauriculata*, Feist. = *G. cyclopteroides*, Feist.
G. cyclopteroides, var. *areolata*, Feist. = *G. cyclopteroides*, Feist.
G. cyclopteroides, var. *attenuata*, Feist. = *G. cyclopteroides*, Feist.
Belemnopteris Wood-Masoniana, Feist.
Sagenopteris longifolia, sp. nov. = *Glossopteris angustifolia*, Brong.
S. (?) *polyphylla*, sp. nov. = *Glossopteris retifera*, Feist.
S. cf. *rhoifolia*, Presl = *Glossopteris*, sp.
S. (?) *Stoliczkana*, Feist. = ? *Glossopteris decipiens*, Feist.
Actinopteris bengalensis, Feist. = [*A.* ?] *bengalensis*, Feist.
Pterophyllum burdwanense (M'Clelland) = ? *Tæniopteris*, sp.
Glossozamites Stoliczkanus, Feist. = *Noeggerathiopsis* (?) *Stoliczkana* (Feist.).
Noeggerathiopsis Hislopi (Bunb.).
Euryphyllum Whittianum, Feist. = *Noeggerathiopsis Whittiana* (Feist.).
Rhipidopsis densinervis, sp. nov.
Voltzia heterophylla, Brong.

In 1881, Feistmantel[1] also instituted the species—

Cyclopitys dichotoma, sp. nov.

The first part of the fourth volume of the Gondwana Flora, published in 1882, contained descriptions of plant-remains from the South Rewah Gondwana basin. Feistmantel,[2] in addition to further figures of several plants already well known, describes the following new species:—

Glossopteris cordata, sp. nov. = cf. *G. Browniana*, Brong.
G. tænioides, sp. nov. = cf. *G. angustifolia*, Brong.
Noeggerathiopsis lacerata, sp. nov. = [*N.* ?] *lacerata*, Feist.

In 1886, Feistmantel[3] completed his Flora of Lower Gondwanas by a memoir on the plants obtained from some of the coalfields in Western Bengal. In addition to figures of several plant-remains previously recorded, the following new varieties were described:—

Gangamopteris cyclopteroides, var. *acuminata*, Feist. = *G. cyclopteroides*, Feist.
G. cyclopteroides, var. *cordifolia*, Feist. = *G. cyclopteroides*, Feist.

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[1] Feistmantel (81[1]), p. 257. [2] Feistmantel (82[1]). [3] Feistmantel (86).

In the second edition of the "Geology of India," edited by R. D. Oldham [1] and published in 1893, a list of Permo-Carboniferous plants is given, as well as figures of the more important species.

The most recent memoir [2] on the Glossopteris flora of India contains the following new species instituted by Professor Zeiller.[3] as well as many figures of some of the earlier described plants:—

Glossopteris tortuosa, sp. nov.
Schizoneura Wardi, sp. nov.
Phyllotheca Griesbachi, sp. nov.
Cycadites (?), sp.
Ottokaria bengalensis, sp. nov.
Araucarites Oldhami, sp. nov.
Cardiocarpus indicus, sp. nov.
Cardiocarpus, sp.

(*b*) *Kashmir*.

Dr. Noetling [4] has recently discovered a *Gangamopteris* in beds overlain by the Permian rocks of the Salt Range Series at Khunmu, in the Vihi Valley, Kashmir. This is an especially interesting discovery, as it confirms the long disputed fact that the Glossopteris flora existed in India in Permo-Carboniferous times, which had previously only been inferred from indirect evidence. Mr. Seward [5] has described this plant as *Gangamopteris kashmirensis*, sp. nov.

(*c*) *Afghanistan and Persia*.

Griesbach [6] has described *Vertebraria*, the rhizome of *Glossopteris*, from rocks believed to be of Permo-Carboniferous age in Afghanistan, and *Glossopteris* from the province of Khorassan in Persia.

(*d*) *Asia Minor*.

It is interesting to record that the most satisfactory specimens showing the fructification of *Phyllotheca* are those described by Professor Zeiller [7] from the Upper Carboniferous rocks of the coal-basin of Heraclea in Asia Minor.

[1] Oldham (93), pp. 162–3, and two plates.
[2] See Appendix. [3] Zeiller (02[1]). [4] Noetling (03), p. 22.
[5] Seward & Woodward (05); and the Appendix to this volume, p. 225.
[6] Griesbach (85), pt. i, p. 62, 1885: pt. ii, p. 59, 1886.
[7] Zeiller (99).

II. Eastern Asia, etc.

(*a*) *Tonquin.*

The flora of the plant-bearing beds of Tonquin has been described by Zeiller[1] in a series of papers published from 1882 onwards. Quite recently these results have been collected in the form of a monograph.[2] The beds are regarded as of Rhætic age, and it will, therefore, only be necessary to notice such members of the Glossopteris flora as have been recorded in association with the Rhætic flora.

Glossopteris indica, Schimper.
G. angustifolia, Brong.
Noeggerathiopsis Hislopi (Bunb.).
Palæovittaria Kurzi, Feist.
Tæniopteris spatulata, M'Clelland.
T. cf. *M'Clellandi* (Oldham & Morris).
Danæopsis cf. *Hughesi*, Feist. = *Sphenopteris* cf. *Hughesi* (Feist.).

(*b*) *China.*

The fossil plants of Palæozoic age described by Schmalhausen,[3] Newberry,[4] Schenk,[5] Abbado,[6] and Zeiller[7] from different parts of China are all typical members of the flora of the Northern Hemisphere, whereas the earlier memoirs of Newberry and Brongniart relate to fossils of apparently Jurassic age.

Krasser[8] has figured several species from China and Central Asia collected by M. Obrutschew during the years 1893–1894. These plants are of different ages, and from various localities. Some of them, such as *Lepidodendron* cf. *Haidingeri*, Ett., and *Cordaites* cf. *principalis* (Germ.), are members of the northern type of Permo-Carboniferous flora. But from San-schi-li-pu, in the province of Schen-si, two typical members of the Glossopteris flora were obtained, namely, *Danæopsis Hughesi*, Feist., and leaves resembling *Noeggerathiopsis Hislopi* (Bunb.).

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[1] Zeiller (82¹), (82²), (86¹), (86²).
[2] Zeiller (02³).
[3] Schmalhausen (83¹), p. 432.
[4] Newberry (83).
[5] Schenk (83), (85).
[6] Abbado (00), p. 127.
[7] Zeiller (01), p. 431.
[8] Krasser (00).

Also in beds regarded as Rhætic in age, near the village of Hsü-kia-hŏ, in the province of Sz'-tschwan, a *Schizoneura* was found which has since been named by Mr. Seward[1] *S. Krasseri*.

Zeiller[2] has recently published an account of some fossils from Southern China. The Rhætic flora of Taï-Pin-Tchang contains *Glossopteris indica*, Feist., in association with *Cladophlebis Ræsserti* (Presl), a typical Rhætic fern-like plant. *Glossopteris indica* is also recorded from Kiang-Ti-Ho, and Professor Zeiller states that this flora compares very closely with that of Tonquin.

(*c*) *Borneo.*

Tenison-Woods[3] has recognised in a collection of fossils from the Sarawak Coalfield in Borneo, *Phyllotheca australis* and *Vertebraria*. The latter is now known to be the rhizome of *Glossopteris*.

III. Central and Northern Asia.

The Altai and Siberia.

Fossil plants from the Altai and Siberia have been described by Göppert,[4] Eichwald,[5] Geinitz,[6] Schmalhausen,[7] and Kosmovsky.[8] Schmalhausen regarded this flora as of Jurassic age, but Zeiller[9] has since shown that it is more closely related to that of the Permian rocks of Europe and North America. *Phyllotheca*, however, is associated with this flora; one species, *P. deliquescens* (Göpp.), described by Göppert and Schmalhausen, being also recorded from Australia.[10] Zeiller[11] has also compared *P. Stschuronowskii*, Schmal. with *P. robusta*, Feist. from the Lower Gondwanas of India. In a recent paper, the same author[12] has concluded that the plants described by Göppert and Geinitz under the name *Noeggerathia*, and by Schmalhausen as *Rhiptozamites*, should be referred to *Cordaites*.

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1 Seward (03), p. 48.
2 Zeiller (00²).
3 Tenison-Woods (85), p. 584.
4 Göppert (45).
5 Eichwald (60).
6 Geinitz (69), (71).
7 Schmalhausen (79), (83¹).
8 Kosmovsky (91); see Zeiller (96²), p. 485.
9 Zeiller (96²), (02²).
10 Arber (02¹), pp. 17, 22.
11 Zeiller (96²), p. 472.
12 Zeiller (02²), pp. 889–90; (96²), p. 486.

IV. Europe.

(a) *Russia.*

In 1897, Amalitzky[1] announced the discovery of *Glossopteris* in the Upper Permian beds of the Soukhona and Petite Dwina, Russia. Attention was called to this discovery by a short note published by Zeiller[2] in the following year. In 1901, Amalitzky[3] recorded several further members of the Glossopteris flora from beds intermediate between a Lower Permian horizon, with *Lepidodendron* and *Callipteris conferta*, and sediments containing Upper Zechstein Mollusca.

Glossopteris indica, Schimper.
G. angustifolia, Feist.
G. stricta, Bunb.
Gangamopteris major, Feist. = *G. cyclopteroides*, var. *major*, Feist.
G. cyclopteroides, Feist.
Vertebraria.

It may perhaps be mentioned that Schmalhausen[4] had already recorded *Phyllotheca* from the Permian of Northern Russia.

(b) *Spitzbergen.*

In 1897, Messrs. Newton & Teall described a few plants collected between Cape Grant and Cape Stephen in Franz Josef Land. Among them was one named *Rhiptozamites* (?) cf. *Göpperti*,[5] a species somewhat similar to certain leaves occurring in the rocks of Gondwanaland. It seems, however, more probable that this fossil is identical with the Mesozoic type of leaf now known as *Phœnicopsis elongatus* (Morris).[6] The other associated specimens recall the plant-remains of a somewhat later period than the Permo-Carboniferous, and in all probability are not of that age.

V. Australasia.

(a) *New South Wales.*

Glossopteris Browniana was first described from Australia by Brongniart[7] in 1828 from specimens derived from the coal-mines

[1] Amalitzky (97).
[2] Zeiller (98^2).
[3] Amalitzky (01), p. 592.
[4] Schmalhausen (79).
[5] Newton & Teall (97), p. 504, pl. xli, figs. 6, 7.
[6] Seward (03^1), p. 67.
[7] Brongniart (28^1), p. 54 ; (28^2), p. 223, pl. lxii, figs. 1, 1*a*.

on the Hawkesbury River, 10 miles to the north of Port Jackson. From the same locality the fern-like plant, figured by Brongniart [1] as *Pecopteris alata*, and now known as *Sphenopteris alata* (Brong.), was recorded. The genus *Phyllotheca*, and the species *P. australis*, were also founded by Brongniart [2] from Australian specimens.

In 1831, Nicol [3] described sections of petrified woods from Tasmania, and two years later he figured other sections from New South Wales. The occurrence of petrified wood in Australia had also attracted the attention of Clarke [4] among the earlier observers.

The first collection of fossil plants from New South Wales was described by Morris [5] in 1845. These specimens are now partly in the British Museum, and partly in the Museum of the Geological Society of London. The following species were obtained from the Newcastle Series:—

Sphenopteris lobifolia, sp. nov.
S. alata, var. *exilis*, Morr. = *S. alata* (Brong.).
Glossopteris Browniana, Brong.
Phyllotheca australis, Brong.

Some two years later, McCoy [6] published an important paper dealing with the plants obtained from several different horizons in New South Wales by the Rev. W. B. Clarke during the years 1839 to 1844. The Clarke collection was presented to the Woodwardian Museum, Cambridge, in 1844, and is now preserved in the Sedgwick Museum of that University. These specimens were re-examined and described more fully in 1902.[7] The following species were determined from the Newcastle Series by McCoy:—

Glossopteris Browniana, Brong.
G. linearis, sp. nov. = *G. Browniana*, Brong.
Vertebraria australis, sp. nov. = *V. indica*, Royle.
Sphenopteris alata (Brong.).
S. germanus, sp. nov. = *S. lobifolia*, Morris.
S. plumosa, sp. nov. = *S. lobifolia*, Morris.
S. flexuosa, sp. nov. = *S. lobifolia*, Morris.
S. hastata, sp. nov. = *S. lobifolia*, Morris.
S. lobifolia, Morris.
Gangamopteris angustifolia, sp. nov.
Phyllotheca ramosa, sp. nov. = *P. australis*, Brong.

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[1] Brongniart (28[1]), p. 58; (28[2]), p. 361, pl. cxxvii. See Arber (02[1]), p. 10.
[2] Brongniart (28[1]), pp. 152, 175.
[3] Nicol (31), (33).
[4] Clarke (43).
[5] Morris (45).
[6] McCoy (47).
[7] Arber (02[1]).

P. Hookeri, sp. nov. (pars) = *P. australis*, Brong.
P. Hookeri, sp. nov. (pars) = *P. deliquescens* (Göpp.).
Zeugophyllites elongatus (Morris) = *Noeggerathiopsis Hislopi* (Bunb.).

McCoy also described two species from beds at Arowa, on a lower horizon than the Newcastle Series:—

Otopteris ovata, sp. nov. = *Aneimites ovata* (McCoy).
Phyllotheca Hookeri, sp. nov. = *P. deliquescens* (Göpp.).

The two following species were recorded in 1902, as new from New South Wales, from among the undescribed specimens in the Clarke collection at Cambridge:—[1]

Sphenopteris polymorpha, Feist.
Cardiocarpus, sp.

Dana,[2] in 1849, published a further list of fossils from New South Wales, collected during the United States Exploring Expedition between the years 1838 and 1842:—

Noeggerathia spatulata, sp. nov. = *Noeggerathiopsis Hislopi* (Bunb.).
N. media, sp. nov. = *Noeggerathiopsis Hislopi* (Bunb.).
N. elongata, sp. nov. (*non* Morris) = *Noeggerathiopsis Hislopi* (Bunb.).
Sphenopteris lobifolia, Morris = ? *S. lobifolia*, Morris.
Glossopteris Browniana, Brong.
G. ampla, sp. nov.
G. reticulum, sp. nov. = *G. Browniana*, Brong.
G. elongata, sp. nov. = *G. Browniana*, Brong.
G. (?) *cordata*, sp. nov. = *G. ampla*, Dana.
G. linearis, McCoy = *G. Browniana*, Brong.
Phyllotheca australis, Brong.
Clasteria australis, sp. nov. = *Vertebraria indica*, Royle.
Anarthrocanna australis, sp. nov. = ?
Cystoseirites (?) = ? roots.
Austrella rigida, sp. nov. = ? roots.
Conferrites (?) *tenella*, sp. nov. = ? roots.

Feistmantel,[3] in 1878, described the following species from the "Lower Coal Measures" of New South Wales, which form the lower series of *Glossopteris*-bearing rocks in that Colony:—

Glossopteris Browniana, Brong.
G. Browniana, var. *præcursor*, Feist. = *G. Browniana*, Brong.
G. primæva, sp. nov. = cf. *G. indica*, Schimper.
G. Clarkei, sp. nov. = cf. *G. Browniana*, Brong.
G. elegans, sp. nov.
Noeggerathiopsis prisca, sp. nov. = cf. *N. Hislopi* (Bunb.).

[1] Arber (02[1]). [2] Dana (49). [3] Feistmantel (78).

In addition to fossils previously recorded, Feistmantel described the following species from the Newcastle Series of New South Wales:—

Glossopteris tæniopteroides, sp. nov. = *G. indica*, Schimper.
G. Wilkinsoni, sp. nov. = *G. Browniana*, Brong.
G. parallela, sp. nov. = cf. *G. Browniana*, Brong.
Gangamopteris Clarkeana, sp. nov. = *G. cyclopteroides*, Feist.
Caulopteris (?) *Adamsi*, sp. nov. = [*Caulopteris* ?] *Adamsi*, Feist.
Brachyphyllum (?) *australe*, sp. nov.

In 1883, Tenison-Woods[1] published an account of the literature and previous records of fossil plants from the coal deposits of Australia. Several new species, some of which undoubtedly require revision, were described by the same author, but these appear to belong to the Triasso-Rhætic or Jurassic floras, and consequently need not be considered here.

Feistmantel,[2] in 1890, contributed an important monograph on the Palæozoic and Mesozoic plants of Australia, founded on his previous work published in 1878. It contains a full account of the literature on the subject, with descriptions and, in many cases, figures of the Glossopteris flora from New South Wales, and elsewhere in Australasia. The following new species were described:—

Glossopteris gangamopteroides, sp. nov. = *G. Browniana*, Brong.
G. spathulato-cordata, sp. nov. = cf. *G. orbicularis*, Feist.

About this period, the occurrence of organic remains in the kerosene shales of New South Wales received considerable attention at the hands of two French Palæobotanists, Professor Bertrand and the late Dr. Renault. A species of *Reinschia*[3] was described by these authors conjointly in 1892, and in 1896 Professor Bertrand described *Pila australis*.[4]

In 1893, Mr. R. Etheridge, jun.,[5] described the first specimens of *Schizoneura* from New South Wales, further and more satisfactory examples being obtained in 1903.

Schizoneura australis, Etheridge = *S. gondwanensis*, Feist.

[1] Tenison-Woods (83).
[2] Feistmantel (90).
[3] Bertrand & Renault (92), (93); also Bertrand (93), (00).
[4] Bertrand (96).
[5] Etheridge (93), (03).

The same author[1] also described in 1895 an interesting fossil which he referred to the genus *Phyllotheca*, and which is here described as *P. Etheridgei*, sp. nov.

In 1897, Dun[2] recorded two new species of *Glossopteris* from the Newcastle Series:—

Glossopteris rectinervis, sp. nov. = cf. *G. Browniana*, Brong.
G. acuta, sp. nov.

(*b*) *Victoria.*

The genus *Glossopteris* has not, so far as I am aware, been recorded from Victoria, although *Gangamopteris* has been known from the colony for many years. The first mention of the latter genus was apparently that by Selwyn[3] in 1866, who identified it from the Bacchus Marsh beds.

In 1875, McCoy[4] described the following forms of *Gangamopteris* from the same horizon and locality:—

Gangamopteris angustifolia, McCoy.
G. spatulata, sp. nov. = *G. cyclopteroides*, Feist.
G. obliqua, sp. nov. = *G. cyclopteroides*, Feist.

In 1878 and 1890, Feistmantel[5] described the above species, without any further additions to the flora except *Phyllotheca australis*, Brong., from Cape Paterson, Victoria.

In 1898, the late Sir Frederick McCoy[6] described a fragmentary portion of a Tæniopteroid frond as *Tæniopteris Sweeti*, which was obtained from the Bacchus Marsh Sandstone.

(*c*) *Queensland.*

In 1872, Carruthers[7] recorded *Glossopteris Browniana* from Queensland. The same author,[8] in 1880, determined the following species in a collection of plants obtained by Mr. Jack from the Bowen River Coalfield, North Queensland:—

Glossopteris Browniana, Brong.
G. linearis, McCoy = *G. Browniana*, Brong.
G. cf. *G. ampla*, Dana.
Phyllotheca australis, Brong.
Araucarioxylon Nicoli, sp. nov. = *nomen nudum*.

[1] Etheridge (95).
[2] Dun (97), p. 64.
[3] Selwyn & Ulrich (66), p. 16.
[4] McCoy (74).
[5] Feistmantel (78), pp. 101–2; (90), pp. 130–33.
[6] McCoy (98).
[7] Carruthers (72), p. 354.
[8] Carruthers (80), p. 325.

Jack & Etheridge[1] recorded the following species from Queensland in 1892 :—

Phyllotheca australis, Brong.
Sphenopteris lobifolia, Morris.
S. flexuosa, McCoy = *S. lobifolia*, Morris.
S. crebra, T.-Woods (?).
Glossopteris Browniana, Brong.
G. linearis, McCoy = *G. Browniana*, Brong.
G. ampla, Dana.
Araucarioxylon Nicoli, Carr. = *nomen nudum*.

In 1898, Shirley[2] described a number of petrified woods from Queensland.

Araucarioxylon Maitlandi, sp. nov. = *Dadoxylon Maitlandi* (Shirley).
A. Binneyi, sp. nov. = *D. Binneyi* (Shirley).
A. Williamsoni, sp. nov. = *D. Williamsoni* (Shirley).
A. brisbanense, sp. nov. = *D. brisbanense* (Shirley).

More recently the same author[3] has figured several species new to Queensland.

Glossopteris Browniana, var. *præcursor*, Feist. = *G. Browniana*, Brong.
G. communis, Feist. = *G. indica*, Schimper.
G. parallela, Feist. = cf. *G. Browniana*, Brong.
G. elegans, Feist.
G. Wilkinsoni, Feist. = *G. Browniana*, Brong.
Sphenopteris alata (Brong.).
Cycadospermum Dawsoni, sp. nov. = *Cardiocarpus* (?) *Dawsoni* (Shirley).
Noeggerathia (?) = ? *Noeggerathiopsis*, sp.

A number of specimens from the Baron River, Queensland, in the National Museum, Melbourne, were described by Chapman in a paper published in 1904.[4]

Phyllotheca australis, Brong.
Glossopteris Browniana, Brong.
G. ampla, Dana.
G. parallela, Feist. = cf. *G. Browniana*, Brong.
Araucarioxylon Daintreei, sp. nov. = *Dadoxylon Daintreei* (Chapman).

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[1] Jack & Etheridge (92), p. 189, etc.
[2] Shirley (98).
[3] Shirley (02).
[4] Chapman (04). I did not have an opportunity of seeing this paper until most of the systematic portion of this work had passed through the press. Consequently these records are not noticed under the specific headings.

This paper also includes a discussion on the fructification of *Phyllotheca australis*, and an account of the distribution of silicified woods in Australia.

It has been stated by several observers that *Glossopteris* occurs in the Desert Sandstone of Queensland, a deposit of Cretaceous age. It was first recorded from these beds by Norman Taylor[1] in the year 1874. In 1890, Rands[2] discovered some specimens, which were identified by Mr. Etheridge, jun. as undoubtedly fronds of *Glossopteris*, and identical with specimens of Permo-Carboniferous age, from beds resembling the Desert Sandstone, and stated to overlie the Rolling Downs formation, at a locality known as Betts Creek, within a mile of Conglomerate Gully in the Cape Goldfield. Dr. Jack[3] afterwards visited this locality, and emphatically confirmed the conclusion that the rocks developed there belong to the Desert Sandstone formation. Despite the authority of these statements, one cannot help feeling that this matter requires yet further confirmation, since this evidence is entirely opposed to that of all the other regions from which Lower Cretaceous plant-remains are known; a flora remarkable for its worldwide uniformity of distribution, and one in which *Glossopteris* does not occur. That genus is unknown elsewhere, in beds of later age than the Rhætic.

(*d*) *Western Australia.*

The records of the Glossopteris flora from Western Australia are few in number. In 1893, the late Mr. Robert Etheridge,[4] sen., detected portions of *Glossopteris* and *Noeggerathia* in coal from the Collie River Coalfield. In the following year, Professor Edgeworth David[5] stated that Mr. B. H. Woodward had recognised *Glossopteris Browniana* from the Gascoyne River, West Australia.

It may be also added that Mr. Kidston[6] has figured imperfect fragments of a *Lepidodendron*, *Stigmaria*, and *Cyperites*-like leaf from Yarralla Hill, near the mouth of May River (King Sound).

[1] See Jack & Etheridge (92), p. 559.
[2] Rands (91), p. 10; see also Jack & Etheridge (92), p. 518.
[3] Jack & Etheridge (92), pp. 518–520, 558; Etheridge & David (94), p. 255.
[4] Etheridge, sen. (93), p. 241.
[5] David, in Etheridge & David (94), p. 256.
[6] Kidston (90), p. 102, pl. iv, figs. 4, 4*a*, 5, 6, 6*a*, 7, 7*a*, 8, 8*a*.

So far as I am aware, no members of the Glossopteris flora have been discovered as yet in South Australia.

(e) *Tasmania.*

The earlier discoveries of plant-remains in Tasmania were of fossils chiefly Rhætic in age. The Glossopteris flora was first recognised by Brough Smyth and McCoy [1] in 1874. Johnston,[2] in 1886, mentions the following species as occurring in the Mersey River and Don Coal-basins:—

Glossopteris Browniana, Brong.
G. ampla, Dana.
Gangamopteris spathulata, McCoy = *G. cyclopteroides*, Feist.
G. angustifolia, McCoy.
G. obliqua, McCoy = *G. cyclopteroides*, Feist.
G. Clarkeana, Feist. = *G. cyclopteroides*, Feist.
Noeggerathiopsis media (?), Dana = *N. Hislopi* (Bunb.).
N. spathulata, Dana = *N. Hislopi* (Bunb.).
N. elongata, Dana = *N. Hislopi* (Bunb.).
N. prisca, Feist. = cf. *N. Hislopi* (Bunb.).
Schizoneura, sp. (?) = ?
Carpolithus (?) *tasmanicus*, sp. nov. = ? *Cardiocarpus*, sp.
Tasmanites punctatus, Newton.

In rocks regarded as Triassic in age, the following species, common also to the Permo-Carboniferous flora, were found:—

Phyllotheca australis, Brong.
Sphenopteris alata (Brong.).
S. plumosa, McCoy = *S. lobifolia*, Morris.
S. lobifolia, Morris.

Johnston,[3] in 1887, recorded the following species from Bruni Island, Southern Tasmania:—

Gangamopteris spathulata, McCoy = *G. cyclopteroides*, Feist.
G. obliqua, McCoy = *G. cyclopteroides*, Feist.
Glossopteris Browniana, var. *præcursor*, Feist. = *G. Browniana*, Brong.

In the same year Johnston [4] also described a number of new species, but the age of the beds from which they were obtained is not very clear, and none of the specimens were figured. In his work on the Geology of Tasmania,[5] published in 1888, figures of

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[1] See Smyth (74), p. 24.
[2] Johnston (86), p. 362.
[3] Johnston (87^1), p. 21.
[4] Johnston (87^2), p. 160.
[5] Johnston (88), pp. 111, 134, pls. viii–x.

Tasmanian specimens of *Glossopteris*, *Gangamopteris*, and other genera are given.

In 1890, Feistmantel[1] published the following list of plants from the Mersey River Beds:—

Phyllotheca australis, Brong.
Glossopteris communis, Feist. = *G. indica*, Schimper.
G. Browniana, Brong.
G. spathulato-cordata, Feist. = cf. *G. orbicularis*, Feist.
G. reticulum, Dana = *G. Browniana*, Brong.
Gangamopteris cyclopteroides, Feist.
G. cyclopteroides, var. *subauriculata*, Feist. = *G. cyclopteroides*, Feist.
G. cyclopteroides, var. *attenuata*, Feist. = *G. cyclopteroides*, Feist.
G. angustifolia, McCoy.
G. spathulata, McCoy = *G. cyclopteroides*, Feist.
G. obliqua, McCoy = *G. cyclopteroides*, Feist.
Noeggerathiopsis Hislopi (Bunb.).
N. spathulata (Dana) = *N. Hislopi* (Bunb.).
Squamæ gymnospermarum.
Samaropsis, sp. (?).

In 1892, Johnston[2] described some further plants from the Henty River.

Glossopteris Browniana, Brong.
G. ovata, sp. nov. = ? *G. ampla*, Dana.

Johnston,[3] in 1894, described a new plant from Ida Bay, Southport, Tasmania, as *Pecopteris lunensis*, which was found associated with *Vertebraria australis*. He states that this species occurs in beds of both Permo-Carboniferous and Mesozoic age in Tasmania. Judging from his drawing, it would appear to be of a type more in common with members of the Triassic flora than with the Permo-Carboniferous.

Two years later,[4] the same author gave a complete list of the Palæozoic and Mesozoic plants known from Tasmania, and also figures a fine specimen of *Sphenopteris lobifolia*, Morr., from Seymour, under the name, *S. Morrisiana*.

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[1] Feistmantel (90), p. 60.
[2] Johnston (92).
[3] Johnston (94), pt. i, p. 170, pl. i, figs. 5-7.
[4] Johnston (94), pt. ii, table opposite p. 62, and p. 58, figs. 14, 15.

(*f*) *New Zealand.*

The Glossopteris flora is not known with certainty from New Zealand.[1] Sir James Hector,[2] in 1878, stated that the beds of Mount Potts are full of the leaves of *Glossopteris*. Further, in 1886, he says that "at the base of the Kaihiku Series are the *Glossopteris* beds of Mount Potts, and in the Kaihiku district *Glossopteris* occurs in the lower beds as developed in Popotunea Gorge." Crié[3] has also recorded *Glossopteris* from beds believed to be of Triassic age at Wairoa. Neither of these discoveries has been since confirmed, and the other genera known from New Zealand appear to be typical of a later period than the Permo-Carboniferous.

VI. South Africa.

(*a*) *Cape Colony, Natal (including Zululand), and the Orange River Colony.*

Apparently the earliest record of fossil plants from South Africa is that of specimens discovered by Bain in the Roggeval (Fish River), which were described by Hooker[4] in 1856, and are here noticed under the name *Schizoneura* (?) *africana*, Feist. Wyley[5] referred the beds from which these fossils were obtained to the Koonap division of the Karoo Series.

Plant-remains from Natal were mentioned by Sutherland as far back as 1855.[6] The first discovery of the Glossopteris flora in South Africa was, however, made by Rubidge[7] in 1859, who obtained specimens from Bloemkop, which he compared with those occurring in India.

Tate,[8] in a paper published in 1867, figured *Glossopteris* and other genera from South Africa. These specimens are now in the Museum of the Geological Society of London. The chief localities were Heald Town (near Fort Beaufort), Bloemkop (near the Sunday's River), Graaf Reinet, and East London.

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[1] See Etheridge & David (94), p. 250.
[2] Hector (78), p. 533; (86), p. 77.
[3] Crié (88), p. 1014.
[4] Hooker (56), p. 227, pl. xxviii, fig. 1.
[5] See Tate (67), p. 172.
[6] Sutherland (55), p. 466.
[7] Rubidge (59), p. 198.
[8] Tate (67), p. 140.

Glossopteris Browniana, Brong.
G. Sutherlandi, sp. nov. = *G. Browniana*, Brong.
Rubidgea Mackayi, sp. nov. = ?
Dictyopteris (?) *simplex*, sp. nov. = ? *Glossopteris retifera*, Feist.
Phyllotheca, sp. = ?

In a synopsis of the Karoo Beds by Professor Rupert Jones, included in Tate's paper, some of the above-mentioned species are stated to be derived from the Beaufort Series. Fossil wood is also mentioned as common. In the same paper, *Lepidodendron*, etc., are recorded from the Wittenberg, Zuurberg, and elsewhere by Wyley.[1] This genus had previously been stated to occur at Jackal's Kop, on the eastern side of the Stormberg range, by Rubidge,[2] who also mentions Calamite-like plants from the western part of the Zuurbergen. It is doubtful, however, if these early determinations of *Lepidodendron* were correct, and the doubt is even stronger with regard to the discoveries next to be described.

Grey,[3] in some remarks on South African plants, published in 1871, recorded *Lepidodendron*, *Sigillaria*, and *Pecopteris* from beds associated with the coal at Andries's Nek, on the north-east margin of the Stormberg range, and 25 miles north-east of Queenstown. Carruthers examined these specimens, and determined the *Lepidodendron* to be *L. crenatum* (Sternberg), which, he observed, was associated with "stems of *Calamites*, perhaps of three species, such as those which have a very slender periphery." Carruthers also records *Pecopteris Cistii* (Brong.) ?, "*Alethopteris Longchitidis*, Stbg., and *Asterophyllites equisetiformis*, Brg." Grey mentioned a *Stigmaria* from "the Carboniferous rocks of Lower Albany," but Carruthers decided that, although this has somewhat the appearance of a *Cyclostigma*, it is a true *Sigillaria*.

Professor Rupert Jones[4] also mentions that Mr. Bristow had recognised *Sigillaria*, *Stigmaria*, *Lepidostrobus*, *Halonia*, and *Selaginites* in the micaceous shales of Port Alfred, on the Albany Coalfield. These conclusions were reviewed by Zeiller[5] in 1883.

Griesbach,[6] in 1871, also recorded *Calamites*, *Equisetum*, and

[1] See Tate (67), p. 173. [2] Rubidge (56), p. 237. [3] Grey (71).
[4] See Grey (71), p. 51. [5] Zeiller (83). [6] Griesbach (71), p. 57.

Lepidodendron from the sandstones associated with the coal at Tulberg, Cape Colony.

It must, however, be pointed out that, despite the records of Rubidge, Wyley, Grey, Carruthers, and Griesbach, there is still grave doubt whether such typical genera of the Northern type of Permo-Carboniferous flora as *Calamites*, *Lepidodendron*, etc. (except *Sigillaria* and *Bothrodendron*), have been really found to occur in South Africa in all these localities. Professor Rupert Jones[1] has expressed hesitation as to whether the plants described by Grey were really derived at all from South Africa, and Mr. Seward[2] has recently supported this conclusion. There are specimens in the British Museum collections (V. 235, V. 2390, and V. 3267) of *Lepidodendron*, *Calamites*, and *Calamocladus*, said to have been derived from the Stormberg Beds, which seem to me to be preserved in shales very unlike any rocks which I have seen from South Africa, and more closely similar to the Coal Measure deposits of this country.

It is possible that in several cases plant-remains which we should now assign to the genus *Phyllotheca* have been mistaken for Calamites.[3] It is also probable that badly-preserved specimens of *Sigillaria* or *Bothrodendron* may have been identified in some cases as *Lepidodendron*. These two genera, characteristic of the Northern type of Permo-Carboniferous flora, have been recently found in association with *Glossopteris* in South Africa. On the other hand, while placing on one side Grey's determinations as extremely doubtful, and bearing in mind the sources of error in identification suggested above, it is not improbable that some of the records of *Lepidodendron* from South Africa may have been quite correct, since there exists in the British Museum collection a specimen from the Orange River Colony, described on p. 162, which can only be interpreted as a decorticated cast of a stem of that genus. For the present, however, there must remain much doubt as to whether such Northern types as *Lepidodendron* are widely distributed in Cape Colony. It is earnestly to be desired that a thorough examination of the flora of the various coalfields of the South African Colonies will be undertaken before very long.

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[1] Jones (86), p. 1417, footnote. [2] Seward (03[1]), p. 88.

[3] See Schwarz (97), pp. 32, 36; Rogers & Schwarz (03), pp. 106-7, 109.

Between 1871 and 1888, *Glossopteris* and other genera were recorded from Cape Colony by Stow,[1] Dunn,[2] Moulle,[3] and Green.[4] Dunn and Moulle again noticed an abundance of *Lepidodendron* in the Karoo beds of Cape Colony. Moulle also recorded *Noeggerathiopsis Hislopi* (Bunb.), and *Gangamopteris cyclopteroides*, var. *attenuata*, Feist., from Kimberley.

The first really important memoir on the fossil plants of Cape Colony dates from 1889. Feistmantel[5] then described the following species from near Kimberley, and from Camdeboo to the west of Graaf Reinet:—

Glossopteris Browniana, Brong.
Gangamopteris cyclopteroides, var. *attenuata*, Feist. = *G. cyclopteroides*, Feist.
Noeggerathiopsis Hislopi (Bunb.).

From beds which he considers to belong to the Beaufort Series, at the Fish River, Bloemkop (near Graaf Reinet), and in Natal, etc., he recorded the following fossils, including some of Tate's species, which he had re-examined:—

Schizoneura (?) *africana*, Feist.
Phyllotheca (?), sp.
Glossopteris Browniana, Brong.
G. angustifolia, Brong.
G. Tatei, Feist. = ? *G. retifera*, Feist.
G. communis, Feist. = *G. indica*, Schimper.
G. stricta, Bunb. = ? *G. stricta*, Bunb.
G. retifera, Feist.
G. damudica, var. *stenoneura*, Feist. = *G. ampla*, Dana.
Rubidgea Mackayi, Tate = ?

Some of the specimens which he figured are in the Museum of the Geological Society of London. Feistmantel[6] also gave a list of plants recorded from the Cape Colony before the year 1889.

In 1901, Mr. Etheridge, jun.,[7] described the following plants from the Saint Lucia Bay Coalfield, Enselini River, Zululand:—

Glossopteris Browniana, var. *indica*, Brong. = *G. indica*, Schimper.
G. Browniana, var. *angustifolia*, Brong. = *G. angustifolia*, Brong.
G. damudica, var. *stenoneura*, Feist. = *G. ampla*, Dana.
G. retifera, Feist.
Angiopteridium spathulatum (M'Clell.) = *Tæniopteris spathulata*, M'Clell.
Phyllotheca Zeilleri, sp. nov.

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[1] Stow (71), p. 546. [2] Dunn (7.). [3] Moulle (85), pp. 212, 233.
[4] Green (88), pp. 241, 246. [5] Feistmantel (89).
[6] Feistmantel (89), pp. 25, 26. [7] Etheridge (01).

In the same year, Anderson[1] also recorded *Glossopteris* and *Phyllotheca* from Zululand, and Victoria County, Natal.

(*b*) *Transvaal.*

One of the first records of *Glossopteris* from the Transvaal was that by Penning,[2] who stated that this plant is found in the "High-level Coalfields" of the Transvaal. He also mentioned the occurrence of *Glossopteris*, *Palæozamia*, and *Rubidgea*, genera previously described from Cape Colony by Tate, at Sand Spruit, near Wimburg. Alford,[3] in 1891, stated that *Lepidodendron*, *Pecopteris*, *Neuropteris*, and ? Cycadean fruits have been recognised in the coal-beds of the Transvaal. Some of these determinations are probably open to doubt. Some three years later, Molengraaff[4] mentioned that *Sigillaria* had been found in coal from Zwartkoppies, 15 kilometres east of Vredeford, and *Gangamopteris* from between Klerksdorp and Driekop.

Potonié,[5] in 1894, recorded *Schizoneura* and *Glossopteris* from the Holfontein Colliery in the Middelburg district. *Lepidodendron* and *Farularia* were also mentioned by Goldmann[6] from Vereeniging, 35 miles south of Johannesburg.

In 1896, Professor Zeiller, in de Launay's[7] "Les mines d'or du Transvaal," gave a short account of the fossils found in the Ecca Series at "Francis" [= Casey's Township] in the neighbourhood of Johannesburg. In the same year, Professor Zeiller[8] published a fuller description of these specimens. This paper is especially remarkable for a detailed study of the morphological features of *Vertebraria*, the rhizome of *Glossopteris*, and also for accurate figures of Brongniart's type-specimens of *Glossopteris indica* and *G. angustifolia*. The fossils described are as follows :—

Vertebraria indica, Royle.
Glossopteris Browniana, Brong.
G. indica, Schimper.
G. angustifolia, Brong.

[1] Anderson (01), pp. 57, 87.
[2] Penning (84), pp. 663, 668, etc.; (91), p. 452.
[3] Alford (91), pp. 63, 64.
[4] Molengraaff (94), p. 236.
[5] Potonié (94), p. 66.
[6] Goldmann (95), p. xxiv.
[7] Zeiller, in de Launay (96), pp. 206–9.
[8] Zeiller (96¹).

Sphenopteris (?), sp.
Phyllotheca, sp.
Noeggerathiopsis Hislopi (Bunb.).
Seeds.

In the following year (1897), an important paper by Mr. Seward[1] was published on the association of *Sigillaria* and *Glossopteris* in South Africa. The species described were obtained from Boschman's Fontein and Maggies Mine in the Middelburg district, from Casey's Township, and from Vereeniging. The beds in question were regarded by Draper[2] as of the same age as the lower portion of the Stormberg Beds of Dunn. There is, however, every reason to attribute them to the Ecca Series. The following genera were recorded by Mr. Seward:—

Glossopteris Browniana, Brong.
G. Browniana, Brong., var. *indica* = *G. indica*, Schimper.
G. Browniana, Brong., var. *angustifolia* = *G. angustifolia*, Brong.
Noeggerathiopsis Hislopi (Bunb.).
Gangamopteris cyclopteroides, Feist.
Vertebraria.
Phyllotheca, sp.
Sigillaria Brardi, Brong.
Conites, sp.
Sphenopteris, sp.
Cardiocarpus, sp.

In 1898, Mr. Seward[3] described further specimens from Vereeniging. He suggested that the fossil leaves known as *Noeggerathiopsis* would perhaps be more correctly referred to the genus *Cordaites*.

Glossopteris Browniana, Brong.
G. Browniana, Brong., var. *indica* = *G. indica*, Schimper.
Gangamopteris cyclopteroides, Feist.
Noeggerathiopsis Hislopi (Bunb.).
Sigillaria, sp.

Andrews,[4] in the same year, also recorded plant-remains from the same district, some of which require revision.

In Mr. Seward's more recent work[5] on "The Fossil Floras of Cape Colony," the following plants from the Ecca Series of

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[1] Seward (97[1]). [2] Draper (97). [3] Seward (98[2]), p. 92.
[4] Andrews (98), p. 146. [5] Seward (03[1]), pp. 76–101.

Worcester, Cape Colony, and Vereeniging, Transvaal, are described :—

Schizoneura, sp. (?).
Glossopteris Browniana, Brong., var. *indica* = *G. indica*, Schimper.
G. Browniana, Brong., var. *angustifolia* = *G. angustifolia*, Brong.
Gangamopteris cyclopteroides, Feist.
Neuropteridium validum, Feist.
Bothrodendron Leslii, sp. nov.
Psygmophyllum Kidstoni, sp. nov.
Noeggerathiopsis Hislopi (Bunb.).

This memoir is remarkable as containing the first record of two members of the Northern type of vegetation, *Bothrodendron* and *Psygmophyllum*, in association with the Glossopteris flora, and also for the first discovery of *Neuropteridium validum* in South Africa; an important and widely distributed plant elsewhere in the rocks of Gondwanaland.

This flora was further discussed by Leslie[1] in 1904.

(c) *Rhodesia.*

The only specimens which have been obtained from Rhodesia are those collected by Mr. Molyneux, which I described in 1903.[2] *Glossopteris Browniana* and other species of the same genus were found at the Sisi siding on the Bechuanaland Railway. An obscure Calamite-like pith-cast was also obtained from the Tuli Coalfield, and specimens resembling decorticated Sigillarias from the Sengwe Coalfield in Northern Matabeleland. These fossils are in the British Museum, and are described in the present volume.

(d) *Portuguese South-East Africa.*

In 1883, Zeiller[3] described an interesting flora from the Tete Coalfield on the Zambesi. It consisted entirely of Upper Carboniferous genera and species, which are among the most abundant in Europe and North America. *Pecopteris arborescens* (Schl.), *Alethopteris Grandini* (Brong.), *Annularia stellata* (Schl.), *Sphenophyllum majus*, Bronn, and *Cordaites borassifolius* (Sternb.) are some

[1] Leslie (04). [2] Arber (03). [3] Zeiller (83).

of those found in this coalfield without any trace of *Glossopteris* or other members of the Glossopteris flora. Zeiller remarked that this assemblage of types is characteristic of the Upper Coal Measures of France, and that it is very remarkable that a flora of the Northern type should have co-existed in South Africa with the Glossopteris flora. The latter is now known to have flourished both to the north and south of the Zambesi region.

(*e*) *German and Portuguese East Africa.*

In 1899, Potonié[1] announced the discovery of members of the Glossopteris flora in both German and Portuguese East Africa. In the following year he[2] figured several species. The following were recorded from Ituli in Portuguese East Africa:—

Glossopteris Browniana, Brong.
G. indica, Schimper.
G. angustifolia, Brong.

Vertebraria, *Glossopteris*, *Schizoneura* cf. *Meriani*, and *Voltziopsis* were described from various localities in German East Africa.

VII. South America.

(*a*) *Brazil.*

In 1836, Unger[3] figured a fragment of a petrified stem of a tree-fern, found by Martius between Oeiras and São Gonçala d'Amarante, in the province of Piauhy. A more complete specimen was described by Brongniart[4] in 1872, as the type of *Psaronius brasiliensis*. A still fuller description of the structure of this fossil is given by Zeiller[5] in his memoir on the fossil flora of Autun and Epinac, where he points out its striking similarity to the silicified Psaronii of Autun of Permian age. Solms-Laubach[6] has recently published an account of what is known as to the history of the type-specimen of this interesting fossil.

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[1] Potonié (99).
[2] Potonié (00), p. 495.
[3] Unger (36), p. lxx, pl. geol. i, fig. 4.
[4] Brongniart (72).
[5] Zeiller (90), p. 246, pl. xxi, fig. 1.
[6] Solms-Laubach (04).

Carruthers,[1] in 1869, described three new species from the basins of Candiota and Jaguarão, in the province of Rio Grande do Sul.[2]

Odontopteris Plantiana, sp. nov. = *Neuropteridium validum*, Feist.
Flemingites Pedroanus, sp. nov. = *Lepidodendron Pedroanum* (Carr.).
Noeggerathia obovata, sp. nov. = *Gangamopteris cyclopteroides*, Feist.

These determinations were revised by Zeiller[3] in 1895, who pointed out the identity of some of these fossils with members of the Permo-Carboniferous flora of India.

In 1870, Plant[4] made the somewhat doubtful record of *Lepidodendron* in association with *Glossopteris* from the same coalfields. Hartt[5] also stated that a specimen greatly resembling *Asterophyllites* (*Calamocladus*) had been found in the southern portion of the province of Bahia.

In 1872, Liais[6] showed that *Sphenopteris* and Calamitean remains occur in the Candiota and Jaguarão Coalfields.

In 1888, Derby,[7] Director of the Geological Section of the National Museum, Rio de Janeiro, in a letter to Waagen, afterwards published, stated that Coniferæ of the *Dadoxylon* type with stems and leaves of *Lepidodendron*, and fragments of *Psaronius*, have been found in the province of São Paulo.

Renault[8] also described a new species of Lycopodean stem as *Lycopodiopsis Derbyi*, from the coal-basin of Piracicaba, in the province of São Paulo. This plant was associated with trunks of tree-ferns (*Psaronius*) and of *Cordaites*. Zeiller[9] has suggested that Renault's *Lycopodiopsis* is a true *Lepidodendron*, and may possibly be a petrified specimen of *Lepidodendron Pedroanum* (Carr.).

In a short series of notices published in 1891, Hettner[10] announced the discovery of representatives of the Glossopteris flora in a coalfield on the river Jacuhy, known as Arroyo dos Ratos. Zeiller,[11] a few years later, examined these specimens,

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[1] Carruthers (69).
[2] See Plant (69).
[3] Zeiller (95^1), (95^2).
[4] Plant (70), pp. 524–5.
[5] Hartt (70), p. 243.
[6] Liais (72), p. 208.
[7] Derby, see Waagen (88), p. 174.
[8] Renault (90^1), p. 109, (92^2).
[9] Zeiller (98^1), p. 215.
[10] Hettner (91).
[11] Zeiller (95^1).

which are in the Berlin Museum, and identified *Gangamopteris cyclopteroides*, var. *attenuata*. As he was the first to point out, there is a remarkable association in Brazil of such typical members of the Glossopteris flora as *Gangamopteris cyclopteroides* and *Neuropteridium validum*, with a common Upper Carboniferous plant of the Northern Hemisphere, *Lepidophloios laricinus*.

In a further paper Zeiller [1] gave a fuller account of these specimens, with additional determinations of leaves of a *Lepidodendron* or *Sigillaria*, various spores of Vascular Cryptogams, and pollen-grains. A new species of Cordaitean stem, from the valley of the Jaguarão, is described and figured as *Dadoxylon Pedroi*, sp. nov.

So far as I am aware, *Glossopteris* itself as yet has not been discovered, beyond doubt, in Brazil, though it has been obtained from the Argentine Republic.

(*b*) *Argentine Republic.*

The earlier descriptions of plant-remains from Argentina relate to fossils which are of Rhætic age.[2] In 1891, Lower Carboniferous plants were described by Szajnocha.[3]

In 1894, Professor Kurtz [4] described members of the Glossopteris flora from the Argentine Republic. The specimens were obtained from Bajo de Velis. Kurtz compared this flora with that of India and South Africa.

Neuropteridium validum, Feist.
Gangamopteris cyclopteroides, Feist.
Noeggerathiopsis Hislopi (Bunb.).
Equisetites Morenianus, Kurtz = ?
Sphenozamites multinervis, Kurtz = *Noeggerathiopsis Hislopi* (Bunb.).
Noeggerathiopsis Hislopi, var. *subrhomboidalis*, Feist. = *N. Hislopi* (Bunb.).
N. Hislopi, var. *euryphylloides*, Kurtz = *N. Whittiana* (Feist.).
Walchia, sp. = ?

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[1] Zeiller (95[2]).
[2] Geinitz (76); Szajnocha (88).
[3] Szajnocha (91).
[4] Kurtz (94[2]).

Glossopteris itself was first recorded from Argentina by Bodenbender[1] in 1895. The following species[2] were identified:—

Glossopteris communis, Feist. = *G. indica*, Schimper.
G. retifera, Feist.
Gangamopteris cyclopteroides, Feist.
Neuropteridium validum, Feist.
Phyllotheca, sp.
Equisetites Morenianus, Kurtz = ?
Lepidodendron Pedroanum (Carr.).
L. Sternbergii, Brong. = *L. lycopodioides*, Sternb.
Noeggerathiopsis Hislopi (Bunb.).
Euryphyllum Whittianum, Feist. (?) = *Noeggerathiopsis Whittiana* (Feist.).
Rhipidopsis ginkgoides, Schmal.
R. densinervis, Feist.
Cyclopitys dichotoma, Feist.

In the same year, Zeiller[3] drew attention to the importance of this discovery, and especially commented on the occurrence of *Rhipidopsis ginkgoides*, a plant already known from the Permian of Russia.

HISTORY OF THE COLLECTION.

The two largest collections of fossil plants from Gondwanaland described here are the Hunter collection from India, and the Odinheimer collection from New South Wales, which, although not important in respect of types or figured specimens, contain many representative examples of the flora.

Hunter Collection. This collection, made by the Rev. R. Hunter, a missionary stationed at Nágpur, was chiefly derived from the Lower Gondwana rocks of that district. The geology of the Nágpur area was described by Hislop & Hunter[4] in 1855, and, in 1861, Bunbury[5] published an account of the fossil plants obtained by these authors. The important types and figured specimens described by Bunbury are preserved in the Museum of

[1] Bodenbender (95), table opposite p. 148.
[2] Bodenbender (96), opposite p. 772.
[3] Zeiller (96^2), p. 466.
[4] Hislop & Hunter (55), see p. 371.
[5] Bunbury (61).

the Geological Society of London. The British Museum received by bequest in 1897 a large number of additional examples.

Odinheimer Collection. An early collection from the Newcastle Series of New South Wales, chiefly from Port Stephens, made by Dr. Odinheimer, and transferred to the British Museum from the Museum of Practical Geology, Jermyn Street. It was originally brought to this country in 1858.

The following collections are especially valuable:—

Nicol Collection. William Nicol, of Edinburgh, famous as the discoverer of the Nicol prism, and as the inventor of the method of making thin, transparent microscopical sections of petrified fossil woods, formed a collection of over 300 sections of plant petrifactions cut by his method. These are of great value historically, being the earliest collection of the kind. These he sold to Mr. J. Bryson, from whom they were purchased by the Museum in 1867. Some of these specimens were described by Nicol[1] between 1831 and 1835.

Royle Collection. Nearly all the types figured by Royle[2] in his work on the Botany of the Himalayan Mountains, published between 1833 and 1839, are preserved in the British Museum. They form the earliest collection of fossil plants from the Lower Gondwanas of India, with the exception of two species previously described by Brongniart. The collection contains four important type-specimens.[3]

Strzelecki Collection and *Morris Collection.* In 1845, Count Strzelecki[4] published a "Physical Description of New South Wales and Van Diemens Land," in which Professor J. Morris[5] described the earliest collection of fossil plants of Permo-Carboniferous age from Australia. One of the species figured, *Glossopteris Browniana*, Brong., as well as some of the Triassic types, are in the British Museum collection, while others are preserved in the Museum of the Geological Society of London. Count Strzelecki sold his collection of 135 fossils to Professor Morris, from whom the Museum purchased them in 1859 and 1883.

[1] Nicol (31), (33), (35[1]), (35[2]). [2] Royle (33). [3] Arber (01).
[4] Strzelecki (45). [5] Morris (45).

The following more recent collections have been previously described, and in many cases the more important specimens have been figured :—

A small collection from Brazil, of great interest, *presented by N. Plant, Esq.*,[1] in 1869, was described by Carruthers[2] in the same year. It includes a type-specimen, and the earliest figured examples of two other species.

A collection of fossil plants from the Permo-Carboniferous rocks of the Transvaal, *presented by David Draper, Esq.*,[3] in 1897, was described and figured by Mr. Seward[4] in that year. It is especially important as demonstrating the association of *Sigillaria* with the Glossopteris flora in South Africa.

A similar, but smaller collection from the same locality, *presented by Dr. F. H. Hatch*[5] in 1898, was also described by Mr. Seward.[6]

A small collection of plants from Rhodesia, the first obtained from that colony, was *presented by A. J. C. Molyneux, Esq.*,[7] in 1901, and was described by the present author[8] in 1903.

Other important collections are the following:—

Sankey Collection. A collection formed by Lieut. R. H. Sankey,[9] R.E., from the Nágpur district in India, and mentioned in his paper published in 1854, was transferred to the British Museum in 1880 from the Museum of Practical Geology.

Claussen Collection. Among the specimens collected by Dr. P. Claussen in Brazil, and purchased by the British Museum in 1841, were slabs of the type-specimen of *Psaronius brasiliensis.*

A collection of more than fifty specimens of fossil plants from the Mersey River Beds in Tasmania was *presented by T. Stephens, Esq.*, in 1898.

In addition to the fossils from the Transvaal, mentioned above, interesting collections from the Orange River Colony, and Natal, were *presented by David Draper, Esq.*, in 1890 and 1893.

A collection of Rhætic plants from Argentina was *presented by H. D. Hoskold, Esq.*, in 1890, with which were two specimens of *Glossopteris* from that country.

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[1] Plant (69). [2] Carruthers (69). [3] Draper (97).
[4] Seward (97¹). [5] Hatch (98). [6] Seward (98²).
[7] Molyneux (03). [8] Arber (03). [9] Sankey (54).

Keene Collection. A small collection of fossil plants from New South Wales, formed by W. Keene,[1] and described by him in memoirs published in 1862 and 1864, was *presented by the Bath Literary and Scientific Society* in 1905.

A piece of fossil wood obtained by the first Livingstone Expedition was *presented by Sir J. Kirk* in 1884.

Other specimens have been presented by the following donors:—

From India: *By C. W. Wilmot, Esq.*, 1883.

From New South Wales: *By Capt. Sir E. Home* in 1853, 1859, and 1860; *by W. L. R. Gipps, Esq.*, 1875; *by Sir C. Purdon Clarke*, 1889; *by W. H. Shrubsole, Esq.*, 1892; *by H. F. Collins, Esq.*, 1903.

From Queensland: *By R. L. Jack, Esq.*, 1879.

From Tasmania: *By G. Sweet, Esq.*, 1900.

From Cape Colony: *By Professor T. R. Jones*, 1884; *by D. D. Fraser, Esq.*, 1893; *Sutherland Collection*,[2] *transferred from the Museum of Practical Geology*, 1880.

From Natal: *By the Rev. G. Smith*, 1876; *by the Natal Government*, 1897.

From Brazil: *By J. Mawson, Esq.*, 1894.

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[1] Keene (62), (64).

[2] Sutherland (55).

THE GLOSSOPTERIS FLORA.

Group THALLOPHYTA.

Class ALGÆ.

The only remains occurring in association with the *Glossopteris* flora which have any claims to be referred to the Algæ, are the somewhat problematical fossils ascribed to the genera *Reinschia* and *Pila* by MM. Bertrand & Renault.

Genus **REINSCHIA**, Bertrand & Renault, 1892.

[Bull. Soc. Hist. nat. d'Autun, vol. v, p. 172.]

The characters of the genus are those of the single species, *Reinschia australis.*

Reinschia australis, Bertrand & Renault.

1892. *Reinschia australis*, Bertrand & Renault, Bull. Soc. Hist. nat. d'Autun, vol. v, p. 172.
1893. *R. australis*, Bertrand & Renault, Bull. Soc. Belge Géol., vol. vii, Mém., p. 64, pl. v, figs. 23–41.
R. australis, Bertrand & Renault, Bull. Soc. Hist. nat. d'Autun, vol. vi, p. 321, pls. iv–vii.
1896. *R. australis*, Bertrand, Bull. Soc. Hist. nat. d'Autun, vol. ix, p. 193.
R. australis, Renault, Bass. houill. et perm. d'Autun et d'Épinac : Flor. foss., pt. ii, p. 540, and text-figs. 137–139.
1898. *R. australis*, Seward, Fossil Plants, vol. i, p. 180, text-fig. 36 (3).
1900. *R. australis*, Bertrand, Ann. Soc. Géol. Nord, Lille, vol. xxix, p. 33.
R. australis, Zeiller, Élém. Paléobot., p. 35, text-fig. 9.

Thallus microscopic, gelatinous, free, sac-like, yellow or orange in colour, composed of cells a single layer in thickness, surrounding a central cavity. The thallus varies considerably in size; from $250\,\mu$ to $600\,\mu$ in length, while the breadth of an average-sized specimen is about $150\,\mu$. The larger thalli are mammillate or cerebriform. The cells are pyriform, with thick, dense walls.

The kerosene shales of New South Wales have been studied by MM. Bertrand & Renault, who have shown that they consist very largely of yellow or orange-coloured bodies, in some respects similar to those which occur in the Boghead coals of Europe. These

authors interpret these bodies as the remains of gelatinous algæ, and distinguish them under the name of *Reinschia*, a genus which they regard as nearly allied to the *Hydrodictyaceæ* or *Volvocineæ*. Mr. Seward[1] has recently discussed the question of the attribution of these fossils.

Not represented in the British Museum collection.

Genus **PILA**, Bertrand & Renault, 1892.

[Bull. Soc. Hist. nat. d'Autun, vol. v, p. 189.]

Thallus microscopic, irregularly spherical or ellipsoidal. Cells varying from 6 to 700, radially disposed in the outer portion of the thallus and pyramidal in shape. The more internal cells are less regularly arranged and polyhedral in form. The size of the thallus varies from ·189 to ·225 mm. in length, and ·136 to ·16 mm. broad.

Several species of *Pila* have been described by MM. Bertrand & Renault from the Bogheads of Scotland and from Autun in France. These coals have proved to consist largely of minute yellow bodies, which these authors regard as the thalli of gelatinous algæ, and which they have referred to this genus. A further species has also been described by M. Bertrand from the kerosene shales of New South Wales.

Pila australis, Bertrand.

1896. *Pila australis*, Bertrand, Bull. Soc. Hist. nat. d'Autun, vol. ix, p. 287.

Thallus regular, ellipsoidal, not lobed, and without invaginations. The surface consists of a regular cellular network with hexagonal meshes. The thalli are hollow. The number of cells varies from 18 to 30, and the cells are disposed in a single row. The size of the thallus is 100 μ along the greater, and 65 μ along the lesser diameter.

Pila australis has been found only in the kerosene shale of Doughboy Hollow, New South Wales.

Not represented in the British Museum collection.

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[1] Seward (98[1]), p. 182.

Group PTERIDOPHYTA (VASCULAR CRYPTOGAMS).

Plants with a well-marked alternation of generations. The sporophyte, or asexual generation, is conspicuous, and constitutes 'the plant.' The sporophyte in nearly all cases is differentiated into root, stem, and leaf, and has a well-developed vascular system. From the asexually produced spore or spores, the gametophyte, bearing the sexual organs, is developed. The gametophyte is usually an inconspicuous and short-lived thalloid body, without vascular tissue.

Classes
- (1) **Equisetales.**
- (2) **Sphenophyllales.**
- (3) **Filicales.**
- (4) **Lycopodiales.**

Class EQUISETALES.

Stems segmented into nodes and internodes; branched or unbranched. The leaves are borne in whorls at the node, and are usually united into a sheath at the base. The sporangia are aggregated in the form of cones or strobili, consisting of sporangiophores bearing sporangia with or without sterile bracts.

The group Equisetales includes the recent genus *Equisetum*, the 'Horsetails,' its sole living representative, and fossils referred to the genera *Equisetites* (plants closely similar in habit to *Equisetum*), *Schizoneura*, *Phyllotheca*, *Calamites*, and *Archæocalamites*. The genera representing this group in the Glossopteris flora are *Schizoneura* and *Phyllotheca*.

Genus **SCHIZONEURA**, Schimper & Mougeot, 1844.

[Monogr. Plant. foss. Grès bigarré Vosges, p. 48.]

The name *Schizoneura* was first proposed by Schimper & Mougeot in 1844 for some specimens of Triassic age from the Vosges. Brongniart had previously described similar specimens

from India under the name *Convallarites*,[1] and possibly also as *Zeugophyllites*,[2] which he classed as Monocotyledons. Schimper & Mougeot, however, pointed out that these fossils were closely allied to members of the class Equisetales, and their name has consequently been adopted.

Schizoneura may be defined as follows:—Stems and branches segmented into nodes and internodes. The internodes are ridged and grooved, the ridges and grooves being usually opposite and not alternate at the nodes. The foliar organs consist of large sheaths without free teeth, which are usually split either into two oval multinerved lobes, or into a number of uninerved segments more or less completely divided. The fructification consists of compact cones borne terminally. The morphology of the strobilus is unknown.

Most of the specimens of *Schizoneura* occurring in association with members of the Glossopteris flora appear to be impressions of the external surface of the stem. Others, although possessing features very similar to those above mentioned, appear to be pith-casts, and there is little doubt that at least some Schizoneuras possessed a hollow medullary cavity similar to that of the Calamite.

Zeiller[3] has recently pointed out that the ridges on the internodes are not always continuous at the node. A similar variation is known among the Calamites, in which the ridges and grooves usually but not always alternate at the node. Zeiller has also compared certain specimens of *Schizoneura* with *Calamites ramosus.*

The structure of the leaf-sheaths is very characteristic of *Schizoneura*. The sheath in the young state is complete, but as it matures it becomes split into a number of segments each with a single nerve, or into two oval lobes with several parallel nerves converging somewhat at the base and apex. The splitting commences at the apex. Similar leaf-sheaths occur in certain living Equiseta, cf. *Equisetum talmateia* (fertile shoots).

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[1] Brongniart (28[1]), p. 128.

[2] Brongniart (28[2]), pp. 118, 121, 175. Brongniart did not publish any figure of this genus, and there has been much confusion as to its nature. The Australian fossils ascribed to *Zeugophyllites* by McCoy are now known to be Cordaitean leaves (see Arber (02[1]), p. 18). Morris' specimens, also assigned to this genus, are now referred to *Phœnicopsis* (Seward (03[1]), p. 67).

[3] Zeiller (02[1]), p. 26.

Distribution.—*Schizoneura* appears first in the Talchir Beds of India (Upper Carboniferous), and occurs also in the Damuda Series (Permian). It is also known from South Africa in beds of Permo-Carboniferous age, and in New South Wales near the top of the Permo-Carboniferous Series. The genus, however, reaches its maximum distribution in beds of Triasso-Rhætic age. In India, Panchet Series;[1] in South Africa, Stormberg Beds;[2] from the Lower Trias of the Vosges,[3] the Upper Trias of Germany;[4] the Rhætic of Sweden, Germany, Persia, Tonquin,[5] China,[6] and elsewhere.

1. Schizoneura gondwanensis, Feistmantel.

(Text-figs. 1–4.)

1876. *Schizoneura gondwanensis*, Feistmantel, Rec. Geol. Surv. India, vol. ix, pt. 3, p. 69.

S. gondwanensis, Feistmantel, Journ. Asiat. Soc. Bengal, vol. xlv, p. 345, pl. xvi, figs. 1–3.

1880. *S. gondwanensis*, Feistmantel, Flora Gondw. Syst., vol. iii, pts. 2, 3, p. 61, pls. IA–XA.

1882. *S. gondwanensis*, Feistmantel, Flora Gondw. Syst., vol. iv, pt. 1, p. 21, pl. xi, figs. 6, 8; pl. xiii, fig. 1; pl. xx, fig. 6.

1886. *S. gondwanensis*, Feistmantel, Flora Gondw. Syst., vol. iv, pt. 2, p. 21.

1893. *S. australis*, Etheridge, jun., Rec. Geol. Surv. New South Wales, vol. iii, pt. 3, p. 74, pl. xiii.

1898. *S. gondwanensis*, Seward, Fossil Plants, vol. i, p. 292, fig. 69.

1902. *S. gondwanensis*, Zeiller, Pal. Indica, N.S., vol. ii, p. 26, pl. vi, figs. 1–4.

1903. *S. australis*, Etheridge, jun., Rec. Geol. Surv. New South Wales, vol. vii, pt. 3, p. 234, pls. xlviii, xlix.

Type. Nos. 5089–5131, Mus. Geol. Surv. India, Calcutta.

Stems articulated, branched. Ridges and grooves of the external casts of stems and especially of branches, not very prominent. Oval scars of the vascular bundles of the leaf-sheath are sometimes seen at the node. Pith (?)-casts more coarsely ridged. Leaf-sheaths large, usually 9 cm. long, but sometimes shorter or even longer, usually split into two oblong or lanceolate multinerved lobes. Each lobe may in turn be divided to the base into 12 to 20 linear uninerved segments. Where the lobes are

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[1] Feistmantel (80).

[2] Seward (03[1]), p. 48.

[3] Schimper & Mougeot (44).

[4] Schenk (65).

[5] Zeiller (02[3]).

[6] Krasser (00).

undivided, splitting may often be seen commencing at the apex. Nerves parallel, undivided, approaching one another at the base and apex. Fructification consisting of compact strobili borne terminally.

The large size and the common occurrence of splitting of the leaf-sheaths are the most important characters of this species (compare Text-figs. 1 and 2).

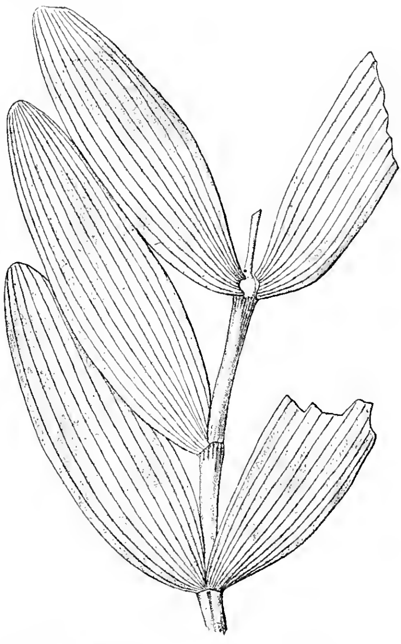

FIG. 1.—*Schizoneura gondwanensis*, Feist. After Feistmantel. $\frac{2}{3}$ nat. size.

Feistmantel[1] has noticed the close similarity between the Indian *Schizoneura* and *S. paradoxa* from the Vosges. He states that the former appears to be "somewhat stronger, and the number of the leaflets composing the sheaths, larger, the sheath portions therefore broader; they also are shorter, their shape more generally oblong-oval." Mr. Seward[2] has recently emphasized the close resemblance between these two plants.

[1] Feistmantel (80), p 63.

[2] Seward (98^1), p. 293.

Several casts of *Schizoneura*, which I regard as probably pith-casts, have been figured by Feistmantel,[1] and one of these is shown in Text-fig. 3*b*. The ridges and grooves in these specimens are much more coarse than in the impressions of the external surface (Text-fig. 3*a*). Some imperfect casts of a similar nature are included in the British Museum collection.

Feistmantel[2] has figured some stems with short broad internodes with oblong leaf-scars at the node, which he has compared with

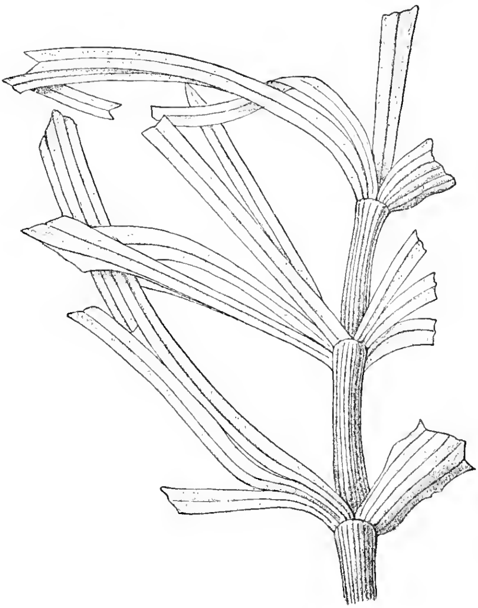

FIG. 2.—*Schizoneura gondwanensis*, Feist. After Feistmantel. Nat. size.

S. meriani (Brong.), from the Trias of Germany. The specimens are, however, too fragmentary for specific determination. Another fragment figured by the same author[3] as *Schizoneura*, sp., is also of a doubtful nature.

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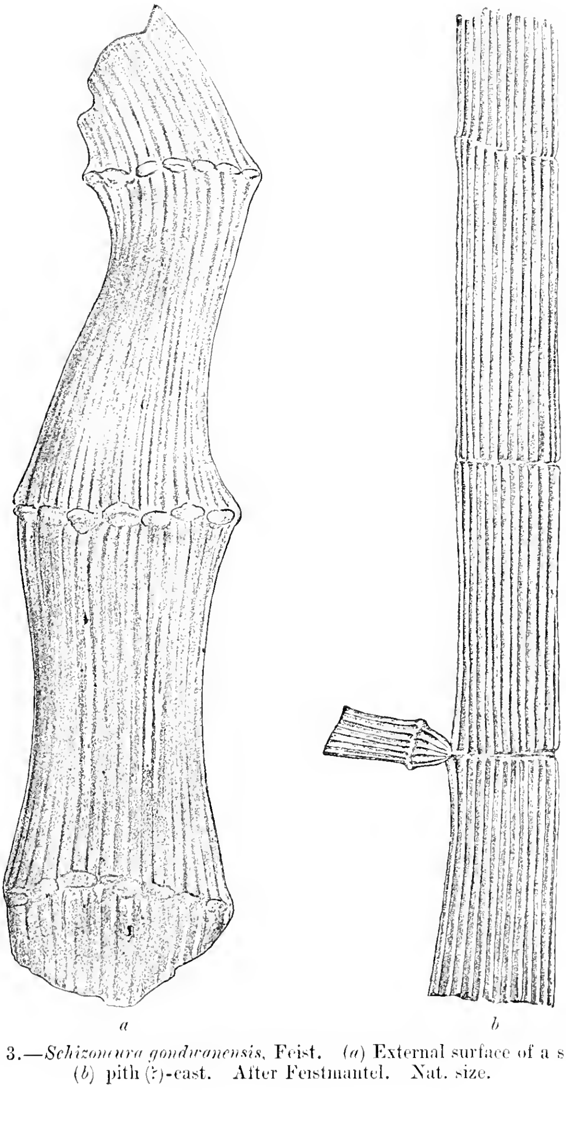
[1] Feistmantel (80), pl. v A, fig. 3; vii A, figs. 1*a*, 1*b*; ix A, fig. 7.
[2] Feistmantel (79[1]), p. 8, pl. i, figs. 6, 7; (80), p. 64.
[3] Feistmantel (79[1]), p. 8, pl. i, fig. 1.



a *b*

Fig. 3.—*Schizoneura gondwanensis*, Feist. (*a*) External surface of a stem; (*b*) pith (?)-cast. After Feistmantel. Nat. size.

Zeiller[1] has recently figured a specimen showing two leaf-bearing branches attached to two successive nodes of a stem at an angle of 45° to 50°. These are the first instances in which such branches have been found attached.

Some years ago Mr. Etheridge, jun.,[2] figured some imperfect fragments of a *Schizoneura*, from a coal-seam near the top of the Upper Productive Coal-measures in New South Wales, as *S. australis*, sp. nov. More recently,[3] better preserved specimens from Balmain, New South Wales, have been obtained, and these appear to me to be identical with *S. gondwanensis*, Feist., of India.

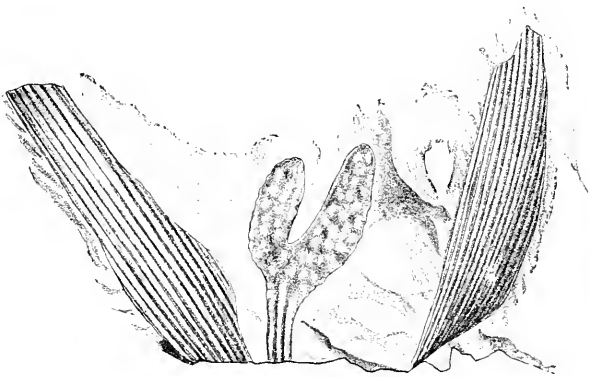


FIG. 4.—*Schizoneura gondwanensis*, Feist. A specimen from New South Wales, showing the cones. After Etheridge. Slightly reduced.

These recent specimens are very interesting, as they show the fructification. In one of the specimens figured the leaf-bearing axis is terminated by a pair of compact strobili of 2–2·5 cm. in length (Text-fig. 4). Unfortunately, however, the preservation is not sufficiently good to afford any details as to the morphological structure of the cone.

Schizoneura gondwanensis is known only from India and New South Wales.

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1 Zeiller (02), p. 26, pl. vi, figs. 1–4.
2 Etheridge, jun. (93), p. 77, pl. xiii; (94), p. 32, pl. vii, fig. 1.
3 Etheridge, jun. (03), p. 234, pls. xlviii, xlix.

Specimens showing the leaf-sheaths.

V. 7197. A specimen showing two twigs each with three or more leaf-sheaths consisting of a pair of oval segments. The parallel nervation is clearly seen. The apparent splitting of one of the oval segments is here probably an accident in the preservation.

India.

V. 4413. A fragment of a branch showing two leaf-sheaths attached to two successive nodes, 2·9 cm. apart. Each leaf-sheath is split into two oval leaf like lobes, and is rather more than 5 cm. in length. A number of parallel veins traverse each lobe, and these are clearly contracted at the base of the sheath.

? Bardwán Coalfield, Raniganj Group, India.

V. 4281. A fragment of a branch showing clearly the venation, and the two oval lobes resulting from the splitting of the leaf-sheath. The veins are parallel, contracting both at the apex and base of the sheath.

India.

V. 7099. A small fragment of a leaf-sheath, similar to V. 4281, showing the nervation clearly.

Bardwán Coalfield.

V. 7099*g*. Fairly well-preserved branch fragments, showing the attachment of the leaf-sheaths to the axis, and the parallel nervation of the oval lobes of the sheath.

Bardwán Coalfield.

V. 7099*e*. A rather faint impression of a number of branches with their bilobed sheaths.

Bardwán Coalfield.

V. 7099*i*. A fairly well-preserved impression of a branch, showing five nodes, and the bilobed leaf-sheaths borne at each node. Some of the segments of the leaf-sheaths are more than 5 cm. long. The nervation is clear, the parallel nerves contracting at the base or point of application of the sheath to the node. In some of the fragments of other branches, which occur on the same piece of sandy shale, the nervation of the leaf-sheath appears to be closer.

Bardwán Coalfield.

V. 7379*b*. A leafy branch, similar to V. 7099*i*, showing the

attachment of the leaf-sheaths to the node, and the delicate longitudinal striations on the internodes. The contraction of the veins at the base of the leaf-sheath is very well seen in this specimen.

Bardwán Coalfield.

V. 4413*a*. A specimen similar to V. 7379*b*, and probably from the same locality.

Other specimens:—**V. 7099***a*, **V. 7099***b*, **V. 7099***d*, **V. 7099***f*, **V. 7099***h*, **V. 4413***b*, **V. 4413***d*, **V. 6074**, **V. 7198**, **V. 7349**; all from India and mostly from the Bardwán Coalfield.

Stem-casts.

V. 7379*a*. A long axis, 32 cm. in length and 2 cm. wide. Five nodes are seen, and portions of six internodes. The internodes are 6·4, 7, 7·6, and nearly 8·9 cm. long respectively. The nodal characters are not very well preserved, but on several of the nodes a row of oval scars can be seen. The characters of this impression agree closely with those of the specimens figured by Feistmantel (80), pl. ixA, figs. 3–6, and pl. viiiA, fig. 4. This stem is associated with foliar branches of *Schizoneura gondwanensis*, and another stem of similar habit.

Bardwán Coalfield.

V. 7099*c*. On the back of this specimen there is a stem-cast, nearly 17·5 cm. long, showing three nodes and portions of four internodes. The striations on the internodes are not prominent, as in pith-casts (?) of *Schizoneura*, the grooves between them being only very slight. At the node there appears to be a ring of small oval scars. These characters are not, however, very clearly seen in this specimen, since the preservation is far from good. This specimen may, however, be compared with Feistmantel (80), pl. ixA, figs. 3–6.

Bardwán Coalfield.

V. 7100*b*. A badly-preserved stem, 2 cm. broad, showing a single node. Possibly similar in character to V. 7379*a*.

Bardwán Coalfield.

V. 7100*c*. A stem-cast, 12·5 cm. long and 16 mm. broad, showing a single node, on which are seen two fairly large subcircular scars, whose greatest diameter is about 5 mm., with umbo-like prominences placed somewhat eccentrically. The long internodes

are striated, the ridges are smooth and not very prominent for the most part, though at one end they are fairly sharp, and agree more closely with the deeply grooved internodes of the other fragments of stems scattered about on the same specimen.

Bardwán Coalfield.

Pith (?)-casts.

V. 7100. A piece of sandy shale, on which are scattered a number of stem-casts. One of the longest of these is 12·5 cm. in length, and 9 mm. across. There are no clear signs of any constriction into nodes and internodes. The cast is sharply ridged, the grooves between the ridges are broad and longitudinally striated. For reasons already explained I am inclined to regard these and similar casts as possibly pith-casts of *Schizoneura.*

Bardwán Coalfield.

V. 7100*a*. This specimen contains several fragments of prominently ridged internodes similar to those above described. No definite evidence as to nodes can be found, although one cast is 15 cm. long. The nodal characters are possibly absent as the result of bad preservation.

Bardwán Coalfield.

V. 6478. A broad cast of a stem, 15 cm. long and 3·5 cm. across. The specimen shows a single node. There are no scars to be seen, and the ridges of the internodes are continuous at the node. It is impossible to say definitely whether such a specimen is a cast of *Schizoneura* or *Phyllotheca.* Its resemblance, however, to the other casts described here suggests provisionally the former genus rather than the latter. Feistmantel (80), pl. VA, fig. 3, has figured a similar specimen.

Bardwán Coalfield.

Other specimens:—**V. 4414, V. 4413***c*.

2. Schizoneura Wardi, Zeiller.

1902. *Schizoneura Wardi*, Zeiller, Pal. Indica, N.S., vol. ii, p. 27, pl. vi, figs. 5–9.

Type. No. 7300–4, Mus. Geol. Surv. India, Calcutta.

Zeiller has recently described this new species as follows:—Stem articulated, surface smooth, leaves numerous, partly connate

at the base or altogether free, 15–30 mm. long, 1·5 – 2 mm. broad, erect, more rarely arched and recurved, narrow, linear-lanceolate, with a not very distinct median nerve.

The surface of the leaves in this species appears to be rather thick, and uniformly striated lengthwise by very fine and close lines, which in the median region become better defined and constitute a more or less distinct median nerve. The variation in the degree of union of the leaves suggests that these plants should be referred to *Schizoneura*. Zeiller states that this species appears to be near that known as *S. meriani* (Brong.).

S. Wardi is known only from the Karharbári Beds at Sasserabhia, India.

Not represented in the British Museum collection.

3. **Schizoneura (?) africana,** Feistmantel.

1852. ——— Hooker, Trans. Geol. Soc., ser. II, vol. vii (1856), p. 227, pl. xxviii, fig. 1.

1890. *Schizoneura* (?) *africana*, Feistmantel, Abhand. böhm. Gesell. Wiss. Prag, ser. VII, vol. iii, p. 41.

1902. *Schizoneura* (?), Arber, Geol. Mag., dec. IV, vol. ix, p. 347.

Type. ? Museum Geol. Soc., London. If the specimen preserved here is the type, the figure given by Hooker is considerably restored.

In a paper read before the Geological Society of London in 1852, Hooker described a specimen discovered by Bain in the Roggeval (Fish River), South Africa. It shows some whorls of leaves united into a cup or sheath at the base, the free segments being of unequal length and breadth, and each traversed by a few parallel and distinct nerves. Some of the leaves show signs of splitting at the apex. Hooker was unable to offer any suggestion as to the nature of this plant. Bain,[1] however, speaks of it as *Asterophyllites* (?).

Feistmantel suggested, in 1890, that this may possibly be a *Schizoneura*, at the same time remarking that the number of segments of the leaf-sheath is much larger than in *S. gondwanensis*, and their substance is thicker and more leathery. He suggested that if this generic determination be accepted, the species

[1] Bain (52), p. 225.

might be called *Schizoneura* (?) *africana*. I have elsewhere expressed an opinion that the South African specimen agrees closely in certain respects with the Indian species of *Schizoneura*. At the same time this plant is too imperfectly known to attempt a satisfactory specific description.

Schizoneura (?) *africana* is known only from South Africa. Some fragments from German East Africa have recently been doubtfully referred to this genus by Potonié.[1] The plant figured by him is a cast of a stem showing ribbed internodes. It is, however, well known that it is impossible, in the absence of leaves, to decide whether such casts should be referred to *Schizoneura* or *Phyllotheca*. Similar specimens have also been described by Seward[2] from Cape Colony, Transvaal, and Natal.

41,285. A very obscure specimen, probably identical with *S. africana* of Feistmantel. Although there is no record, this specimen is probably one of those collected by Bain. It shows portions of three leaves, each with several parallel veins, obscurely united into a sheath at the base. The apex of the segments is not seen.

Roggeval (Fish River).

[Actinopteris] bengalensis, Feistmantel.

(Text-fig. 5.)

1876. *Actinopteris bengalensis*, Feistmantel, Rec. Geol. Surv. India, vol. ix, pt. 3, p. 76.

A. bengalensis, Feistmantel, Journ. Asiat. Soc. Bengal, vol. xlv, pt. 2, p. 377.

1880. *A. bengalensis*, Feistmantel, Flora Gondw. Syst., vol. iii, pts. 2, 3, p. 115, pl. xix A, figs. 1, 1*a*.

Type. Mus. Geol. Surv. India, Calcutta.

Stem unknown. Leaves whorled. United at the base, and for about two-thirds of their length. Whorls disc-like, spreading horizontally, elliptic. Free segments numerous, 80 or more in a whorl, uninerved, often transversely wrinkled near the apex, unequal in length.

Feistmantel referred the single known fragment of this plant to the genus *Actinopteris*, instituted by Schenk[3] for the reception

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[1] Potonié (00), p. 503, fig. 28.

[2] Seward (97¹), p. 324; (03¹), p. 79; (04), p. 101.

[3] Schenk (67), p. 23.

of certain Mesozoic fern-like plants. *Actinopteris bengalensis* was described by Feistmantel as follows:—Leaves orbicular or broadly oval, and as it appears peltate, composed of segments deeply cut, with a central point of insertion; nerves radiating.

Zeiller[1] has recently examined the type-specimen, and has modified Feistmantel's description in certain respects. He points out that the leaves are joined together for about two-thirds of their length, and that the whorls, in the living state, must have

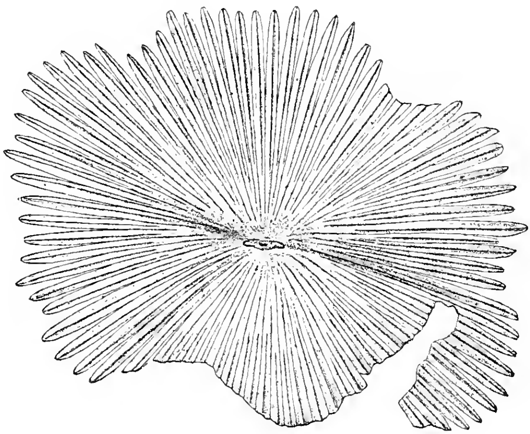

FIG. 5.—[*Actinopteris*] *bengalensis*, Feist. After Feistmantel. Nat. size.

spread out horizontally in the form of a flattened disc. There is no evidence that the whorl consists of six segments as Feistmantel supposed.

I agree entirely with Zeiller's conclusion that these specimens, so far as one can judge from the small fragments known, should be referred to the Equisetales, and not to the Ferns. Zeiller has also expressed the opinion that, if we had more complete evidence, this plant would probably be found to constitute a new genus, but that the material is at present too imperfect to warrant the institution of a new name. I have, therefore, placed it here, with Feistmantel's generic name in square brackets, indicating that this is incorrect,

[1] Zeiller (02[1]), pp. 28, 29.

but that, at present, it does not seem desirable to adopt another in its place.

This plant is known only from the Raniganj Coalfield, Raniganj Group, India.

Not represented in the British Museum collection.

Genus **PHYLLOTHECA,** Brongniart, 1828.

[Prodr. Hist Végét. foss., pp. 151, 175.]

"Plants resembling in habit the recent Equisetums. Stems simple or branched, divided into distinct nodes and internodes, the latter marked by longitudinal ridges and grooves; from the nodes are given off leaf-sheaths consisting of linear-lanceolate uninerved segments coherent basally, but having the form of free narrow teeth for the greater part of their length. The long free teeth are usually spread out in the form of a cup and not adpressed to the stem, the tips of the teeth are often incurved. The sporangia are borne on peltate sporangiophores attached to the main stem between whorls of sterile leaves." [1]

Phyllotheca was first described by Brongniart in 1828, from specimens from the Hawkesbury River, near Port Jackson, Australia. The genus is best known from Australia, Asia Minor, and from Siberia.

Phyllotheca appears, like *Calamites*, to have possessed a hollow pith-cavity, and some of the casts referred to this genus are probably pith-casts. In such, the ridges and grooves of the internodes are continuous and not opposite at the nodes. It is practically impossible to distinguish such pith casts from those of *Schizoneura*.

Branches occur in some specimens, and branch-scars are sometimes found at the node.

Mr. Seward [2] has recently compared the leaf-bearing branches of *Phyllotheca* with *Annularia* and *Calamocladus*, types of Calamitean foliage, to which they present many points of resemblance, thus leading to the conclusion that a close affinity exists between these three genera.

Distribution.—Permo-Carboniferous (Glossopteris flora):—India, in the Raniganj Series only; New South Wales, in the "Lower

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[1] Seward (98[1]), pp. 281, 282. [2] Seward (98[1]), p. 289.

Coal Measures," and Newcastle Series; Queensland; Tasmania, in the Mersey River Beds; South Africa, in the Ecca Beds; South America (Brazil). *Upper Carboniferous* (Northern Type):—Asia Minor. *Permian* (Northern Type):—Russia, Siberia, the Altai. *Triassic and Rhætic*:—New South Wales, in the Wianamatta Series; ? Queensland, in the Ipswich Beds; Tasmania; Tonquin. *Jurassic*:—Italy.

1. Phyllotheca australis, Brongniart.

(Pl. II, Figs. 6–8.)

1828. *Phyllotheca australis*, Brongniart, Prodr. Hist. Végét. foss., p. 152.
1833–5. *P. australis*, Lindley & Hutton, Foss. Flora, vol. ii, p. 89.
1845. *P. australis*, Morris, in Strzelecki's New South Wales, p. 250.
1847. *P. australis*, McCoy, Ann. & Mag. Nat. Hist., vol. xx, p. 156.
P. ramosa, McCoy, ibid., p. 156, pl. xi, figs. 2, 3.
P. Hookeri, McCoy, ibid., p. 157, pl. xi, figs. 4–6.
1849. *P. australis*, Dana, in Wilkes' U.S. Explor. Exped., vol. x, p. 718, pl. xiii, fig. 6.
1850. *P. australis*, Unger, Gen. et Spec. Plant. foss., p. 73.
P. ramosa, Unger, ibid., p. 73.
P. Hookeri, Unger, ibid., p. 73.
1869. *P. australis*, Schimper, Traité, vol. i, p. 289.
1878. *P. australis*, Feistmantel, Palæontogr., Suppl. iii, p. 83, pl. vi, fig. 3; pl. vii, figs. 1 and 2; pl. xv, figs. 1 and 2 (?).
1883. *P. australis*, Tenison-Woods, Proc. Linn. Soc. New South Wales, vol. viii, p. 72.
P. ramosa, Tenison-Woods, ibid., p. 73.
P. Hookeri, Tenison-Woods, ibid., p. 73.
1886. *P. australis*, Johnston, Papers and Proc. R. Soc. Tasmania for 1885, p. 365.
P. ramosa, Johnston, ibid., p. 365.
P. Hookeri, Johnston, ibid., p. 365.
1890. *P. australis*, Feistmantel, Mem. Geol. Surv. New South Wales, Pal., No. 3. p. 79, pl. xiv, figs. 2–5.
P. ramosa, Feistmantel, ibid., p. 80.
P. Hookeri, Feistmantel, ibid., p. 81.
1892. *P. australis*, Jack & Etheridge, Geol. and Pal. Queensland, p. 189, pl. xvii, fig. 13.
1895. *Phyllotheca*, sp., Etheridge, Rec. Geol. Surv. New South Wales, vol. iv, p. 148, pl. xviii, figs. 4, 5.
1898. *P. australis*, Seward, Fossil Plants, vol. i, p. 287.
1902. *P. australis*, Arber, Quart. Journ. Geol. Soc., vol. lviii, p. 14.

Type. ? Muséum d'histoire naturelle, Paris.

Stems branched. External casts of stems and branches with faintly striated internodes. Scars of the vascular bundles of the

leaf-sheath seen between the ridges at the node in favourable specimens in which the leaf-sheath is absent. Nodes sometimes slightly tumid, and ridges of the internodes often puckered at the node. Large branch-scars occur occasionally above the node. Pith (?)-casts imperfectly known, apparently more coarsely ribbed than casts of the external surface. Leaf-sheaths usually shorter than the internodes, and generally closely appressed to the axis, sometimes rather lax. Free segments linear, uninerved, 14 to 24 or more, often reflexed. Fructification imperfectly known.

The size of the leaf-sheath varies greatly in different specimens. Those of the main axes, with internodes 2·5 or 3 cm. long, and 6–28 mm. across, are 13 mm. in length, and the free segments 3·8 cm. long. In the case of branches with internodes of 13 mm. in length, the leaf-sheaths are smaller and less than 7 mm. long, and the free segments average about 6 mm. in length. These small leaf-sheaths commonly occur detached and isolated. (Pl. II, Figs. 7 and 8.)

The evidence as to the fructification of *Phyllotheca australis* is very scanty. The best known cone is that of *P. Rallii*, a Carboniferous species from Asia Minor, described a few years ago by Professor Zeiller.[1] In this case the strobilus consists of alternating verticils of sterile bracts, and sporangiophores. The latter arise perpendicular to the axis, and bear four ovoid sporangia on the inner side of a peltate, distal expansion. It must be confessed that the general character of this cone is singularly like that of the Calamitean fructification *Calamostachys*; an indication of the close affinity of these two genera.

McCoy[2] has figured a specimen from Newcastle, New South Wales, now in the Sedgwick Museum, Cambridge, which may possibly be a fructiferous branch of *Phyllotheca australis*. A careful re-examination[3] of this specimen has not added anything further to our knowledge, as the preservation is far from good. It consists of an axis, segmented into a number of short internodes, without any definite evidence as to the presence of leaf-sheaths, or of sporangiophores; but on either side of the axis bunches of small

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[1] Zeiller (99), p. 65, pl. v, figs. 2–12.
[2] McCoy (47), p. 155, pl. xi, fig. 1.
[3] Arber (02^1), p. 16.

ovate bodies occur closely attached to the node, and these may possibly be sporangia.

I have recently shown elsewhere[1] that McCoy's species, *P. ramosa* and *P. Hookeri* (in part), cannot be clearly distinguished from Brongniart's *Phyllotheca australis*. The former differs only in possessing branched stems, while in the latter species the leaf-sheath appears to be rather looser, and less closely applied to the stem than in *P. australis*. Under the name *P. Hookeri*, McCoy[2] has also included some "coarsely sulcate or ridged stems," which are now removed to another species, *P. deliquescens* (Göpp.), see p. 22, as they are believed to be identical with the Siberian species described under that name by Göppert and Schmalhausen. The type-specimens of McCoy are in the Sedgwick Museum, Cambridge.

Phyllotheca australis is known only from Australia and Tasmania.

Stem-casts and impressions.

V. 7285. Pl. II, Fig. 6.

A fragment of a stem, 6·3 cm. long and 1·5 cm. broad, showing two nodes and three internodes. The longitudinal striations on the internodes are very faint. The ridges are puckered at the node. Leaves are absent in this specimen.

Port Stephens, New South Wales. *Odinheimer Coll.*

V. 7217. Several fragments of stem-casts, one of which is 2·8 cm. broad and 8·9 cm. long. The ridges are continuous, and slightly tumid at the node, and the scars of the vascular bundles of the leaves are seen between them. A smaller fragment shows a branch-scar.

Port Stephens, New South Wales. *Odinheimer Coll.*

V. 7228. A cast much more strongly ribbed than in the preceding specimens, and possibly of the nature of a pith-cast. The node is somewhat constricted, and the ridges are apparently not continuous in all cases.

Australia. *Odinheimer Coll.*

V. 7218. Fragments of stem-casts associated with leaf-sheaths. One cast shows a branch-scar. The ridges at the node are puckered, and the vascular scars are plainly seen.

Port Stephens, New South Wales. *Odinheimer Coll.*

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[1] Arber (02[1]), p. 14. [2] McCoy (47), p. 157.

V. 4289. An obscure fragment showing traces of branch-scars at some little distance above the node.

Port Stephens, New South Wales. *Odinheimer Coll.*

Other specimens:—**39,140**, **39,140*a***, **39,141**, **39,142**, **V. 4198*a***, **V. 4289**, **V. 7287** (from Port Stephens, New South Wales; *Odinheimer Coll.*), ? **V. 10,653** (from Sydney; *Keene Coll.*).

Specimens showing the leaves.

V. 7215. Pl. II, Fig. 8.

Fragment of a detached leaf-sheath, showing the sheath clearly, and the long linear free segments.

Port Stephens, New South Wales. *Odinheimer Coll.*

V. 7286. Pl. II, Fig. 7.

A detached leaf-sheath with seventeen or more free segments, which are about 1 cm. long. The spreading or star-like habit of the free segments is clearly seen.

Port Stephens, New South Wales. *Odinheimer Coll.*

V. 7284. Two detached leaf-sheaths showing the characters of the sheath. One of these has twenty-four free segments, and the other about twenty.

Australia. *Odinheimer Coll.*

V. 4198. A detached leaf-sheath with twenty-one free segments.

Port Stephens, New South Wales.

53,575. Very imperfect fragments of leaf-sheaths.

Cockatoo Creek, North Queensland.

Presented by R. L. Jack, Esq., 1879.

Other specimens:—**V. 7216**, **V. 7214.**

Port Stephens, New South Wales. *Odinheimer Coll.*

2. Phyllotheca indica, Bunbury.

(Text-fig. 6.)

1861. *Phyllotheca indica*, Bunbury, Quart. Journ. Geol. Soc., vol. xvii, p. 335, pl. x, figs. 6–9.
1869. *P. indica*, Schimper, Traité, vol. i, p. 289.
1876. *P. indica*, Feistmantel, Journ. Asiat. Soc. Bengal, vol. lxv, pt. 2, p. 346.
1880. *P. indica*, Feistmantel, Flora Gondw. Syst., vol. iii, pts. 2, 3, p. 67, pl. xii A, figs. 3–9.
1893. *P. indica*, Oldham, Man. Geol. India, pl. opp p. 162.
1898. *P. indica*, Seward, Foss. Plants, vol. i, p. 287, fig. 68*c*.

Type. Nos. R. 10,371–R. 10,374, Mus. Geol. Soc. London.

Bunbury defined his species as follows:—"Stem branched, furrowed; sheaths lax, somewhat bell-shaped, distinctly striated; leaves narrow linear, with a strong and distinct midrib, widely spreading and often recurved, nearly twice as long as the sheaths."

Mr. Seward [1] has recently concluded that it is practically impossible to distinguish Bunbury's type-specimens from *Phyllotheca australis.* In the latter species, however, the leaf-sheaths, throughout their entire length, appear to be closely applied to

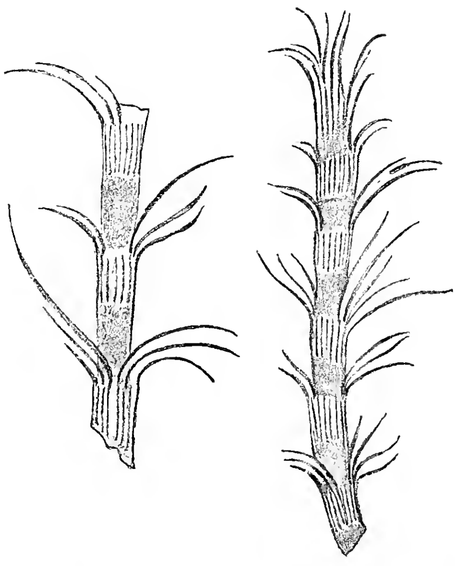

FIG. 6.—*Phyllotheca indica*, Bunb. After Feistmantel. Nat. size.

the stem, the narrow free segments radiating outwards from the margin, whereas in the Indian form the sheath is usually somewhat more open and cup-like. It is doubtful if this character alone is sufficient to warrant specific rank, but since some difference of opinion exists as to the identity of these two plants, the two species may be maintained for the present, especially as the Indian form is still very imperfectly known. The specimens described by

[1] Seward (98^2), p. 288.

Feistmantel in 1880 add practically nothing to our knowledge of this plant.

Phyllotheca indica is known only from the Raniganj group, India.

Stem-casts.

V. 7114. A small fragment, probably from the Nágpur district, about 6 cm. long, showing four internodes and three nodes.

India. *Hunter Coll.*

V. 7195. A small portion of a stem-cast, with faintly ridged internodes, probably belonging to this genus.

Near Nágpur, India. *Sankey Coll.*

V. 7196. A very imperfect fragment of a stem showing the ridges continuous at the node.

Near Nágpur, India. *Sankey Coll.*

V. 7148. A stem-cast similar to V. 7196, in association with *Glossopteris.*

Silewáda, 12 miles north of Nágpur, India. *Hunter Coll.*

Other specimens:—**V. 7113** (from Bharatwáda, 9 miles north of Nágpur); **V. 7111** (from India); **V. 7112** (from Bhokara, 6 miles north of Nágpur, India); **V. 7117** (same locality as V. 7112).

Hunter Coll.

Specimens showing leaf-sheaths.

V. 7115. A small portion of a stem, probably from the Nágpur district, 3·8 cm. long, showing fragments of a leaf-sheath.

India. *Hunter Coll.*

V. 7116. A fragment of a stem or branch showing the free segments of a leaf-sheath.

India. *Hunter Coll.*

3. Phyllotheca deliquescens (Göppert).

(Text-fig. 7.)

1845. *Anarthrocanna deliquescens*, Göppert, in Tchihatcheff's Voy. Scient. Altaï Orient., pp. 379–388, pl. xxv, figs. 1, 2.

1847. *Phyllotheca Hookeri* (in part), McCoy, Ann. & Mag. Nat. Hist., vol. xx, p. 157, pl. xi, fig. 7.

1850. *Anarthrocanna deliquescens*, Unger, Gen. et Spec. Plant. foss., p. 54.

1861. ? *Phyllotheca indica* (in part), Bunbury, Quart. Journ. Geol. Soc., vol. xvii, p. 335, pl. xi, fig. 1.

1879. *P. deliquescens*, Schmalhausen, Mém. Acad. Imp. Sci. St. Pétersb., ser. VII, vol. xxvii, pp. 12–14, 66, pl. i, figs. 1–3; pl. ix, figs. 16, 17; pl. x.

1880. ? Equisetaceous stem, Feistmantel, Flora Gondw. Syst., vol. iii, pts. 2, 3, pl. xiii A, fig. 7.
1890. *Phyllotheca australis* (in part), Feistmantel, Mem. Geol. Surv. New South Wales, Pal., No. 3, p. 79, pl. xiv, fig. 5.
1891. *P. deliquescens*, Solms-Laubach, Fossil Botany, p. 181, fig. 17 B.
1898. *P. deliquescens*, Seward, Fossil Plants, vol. i, pp. 283–286.
1900. *P. deliquescens*, Zeiller, Élém. Paléobot., p. 165, text-fig. 116.
1902. *P. deliquescens*, Arber, Quart. Journ. Geol. Soc., vol. lviii, pp. 17, 22, pl. i, fig. 3.

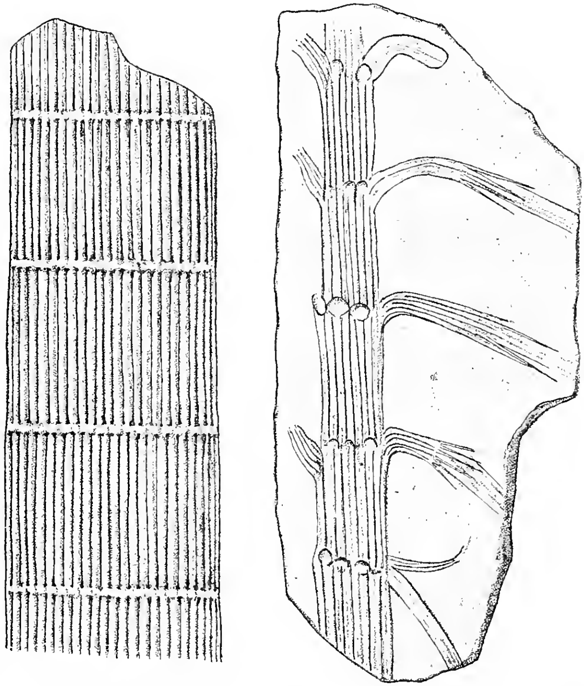

FIG. 7.—*Phyllotheca deliquescens* (Göpp.). After Schmalhausen. Nat. size.

Pith-casts usually broad, articulate; internodes coarsely sulcate, the ridges and grooves opposite at the nodes. Stem-casts stout, with internodes as much as 10 cm. long; internodes strongly ridged and grooved. Whorls of branches may arise at the node. Leaf-sheaths well developed, funnel-shaped; free segments long, linear, spreading, each traversed by a median vein. Fructification

imperfectly known; a loose strobilus consisting of alternate whorls of bracts and clusters of sporangiophores.

This species is imperfectly known. The stem- and pith-casts are generally broader, stouter, and more coarsely sulcate than those of *Phyllotheca australis* or *P. indica*. The leaves of this species are known only from the imperfect specimens figured by Schmalhausen from the Altai and Siberia. Pith-casts very similar, so far as one can judge from such imperfect fragments, to those figured by Schmalhausen, occur in the Permo-Carboniferous rocks of Australia and possibly also in India and South Africa. Several specimens from New South Wales, described by McCoy in 1847 as *P. Hookeri* (in part), and now preserved in the Sedgwick Museum, Cambridge, have been referred to this species.[1] Some of these were recognized by Schmalhausen in 1879 as identical with Göppert's species. The internodes of these casts vary from 1·5 to 3 cm. in breadth, and bear from 35 to 45 sharp longitudinal ridges separated by shallow grooves, about 1 mm. across.

It is possible that a somewhat similar cast figured by Bunbury[2] in 1861 from Nágpur, India, may belong to this species. As this specimen is not to be found among Bunbury's collection, preserved in the Museum of the Geological Society of London, I have not been able to determine whether this is really the case. Possibly also the specimen figured by Feistmantel[3] as an Equisetaceous stem may belong to Göppert's species.

Lastly, the *Phyllotheca* from Zululand, recently figured by Etheridge (see p. 29), may prove eventually to belong to *P. deliquescens*.

The fructification of this species is known only from Schmalhausen's[4] specimens. The loose cone here consists of alternations of whorls of sterile bracts with clusters of peltate sporangiophores.

Known from New South Wales and possibly also from India and South Africa. *P. deliquescens* also occurs in Northern Asia.

Not represented in the British Museum collection.

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1 Arber (02^1), pp. 17, 22.
2 Bunbury (61), pl. xi, fig. 1.
3 Feistmantel (80), pl. xiii A, fig. 7.
4 Schmalhausen (79), pl. ix; Solms-Laubach (91), p. 181, fig. 17 B.

4. Phyllotheca Griesbachi, Zeiller.

1902. *Phyllotheca Griesbachi*, Zeiller, Pal. Indica, N.S., vol. ii, p. 30, pl. vii, fig. 1.

Type. No. 7305, Mus. Geol. Surv. India, Calcutta.

Zeiller has recently established this species on the following characters:—Stem articulate, finely sulcate; internodes 1 cm. to 1·5 cm. long; leaves numerous, 20 to 25 mm. long, united at the base to form a sheath 1 cm. long; free segments linear and acuminate; sheath contracted at the base, but lax distally, and expanding into an almost horizontal disc.

The single specimen, described by Zeiller, shows three stems arranged side by side, which may be three secondary branches springing from the successive internodes of a primary axis. There appear to have been some 30 or 40 leaves in each whorl, which are erect near the base, but rapidly spread outwards in an almost horizontal direction. The sheath is lax in this species.

Zeiller remarks that this species offers some comparison with that described from the Lower Tunguska (Siberia) by Schmalhausen[1] as *P. equisetitoides*. In the latter species, however, the dimensions of the stems are much greater, and the leaf-sheaths are closely applied to the stem throughout the entire length of the internode.

The general character of the disc of *P. Griesbachi* is similar to that of the *Phyllotheca* described by Etheridge[2] from New South Wales (see p. 26), but in the Australian plant the free segments are reduced to short teeth.

Phyllotheca Griesbachi is only known from the Barakar Group of the South Rewah basin, India.

Not represented in the British Museum collection.

5. Phyllotheca robusta, Feistmantel.

(Text-fig. 8.)

1880. *Phyllotheca robusta*, Feistmantel, Flora Gondw. Syst., vol. iii, pts. 2, 3, p. 68, pl. xiv A *bis*, figs. 1, 1*a*, and 2.

Type. Nos. 5161–2, Mus. Geol. Surv. India, Calcutta.

Stems branched; branches slender, articulated, finely striated. Free leaf-segments 10–14, lanceolate, united at the base into a sheath; longitudinally striated, with an indistinct midrib.

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[1] Schmalhausen (79), p. 71, pl. xii, figs. 1–4.

[2] Etheridge (95), p. 148, pl. xvii; pl. xviii, fig. 3.

This species is very imperfectly known, only a few specimens having been obtained from Dudrajpur, in the Rájmahál Hills, the horizon of which is doubtfully assigned to the Raniganj group. The union of the leaves into a sheath, near their attachment to the node, is not very obvious in the figures given by Feistmantel. If this plant is correctly assigned to the genus *Phyllotheca*, the comparatively broad character of the free segments easily distinguishes it from the other Phyllothecas belonging to the Glossopteris flora. There is, however, a species occurring in Altai Coalfields described by Schmalhausen [1] as *Phyllotheca Stschurowskii*, which closely resembles the Indian plant, as

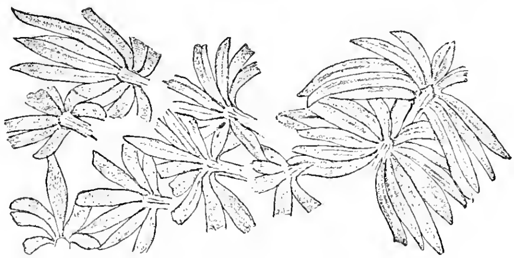

FIG. 8.—*Phyllotheca robusta*, Feist. After Feistmantel. Nat. size.

Feistmantel [2] and Zeiller [3] have already pointed out. Schmalhausen's specimens, however, are too imperfect to justify a correlation.

Known only from India.

Not represented in the British Museum collection.

6. Phyllotheca Etheridgei, sp. nov.

(Text-fig. 9.)

1895. *Phylliotheca*, sp., Etheridge, jun., Rec. Geol. Surv. New South Wales, vol. iv, pt. 4, p. 148, pl. xvii, figs. 1–9; pl. xviii, fig. 3.

1902. *Phyllotheca*, sp., Zeiller, Pal. Indica, N.S., vol. ii, p. 31.

Type. Australian Museum, Sydney.

Leaf-bearing stems articulate, faintly ribbed longitudinally. Leaf-sheath large, narrow and clasping for about 3 mm. at the base, but expanding above into an open peltate disc with a diameter

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[1] Schmalhausen (79), p. 16, pl. iii, fig. 2*b*; pl. iv, fig. 4*b*; pl. vi, figs. 2, 3.

[2] Feistmantel (80), p. 69.

[3] Zeiller (96[2]), p. 472.

of 2·5 – 3 cm. The free segments are reduced to very short teeth, 3 mm. in length, and are twenty-three or more in number. A nerve traverses the sheath to each tooth, between the nerves there is a "faint groove or depression," and also "the finest possible transverse striæ, arranged in a festoon-like manner."[1]

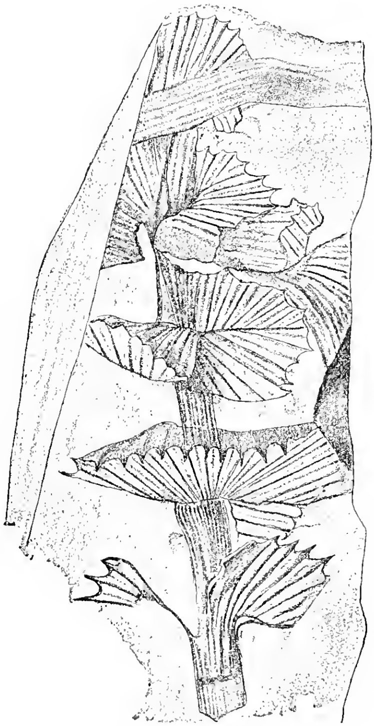

FIG. 9.—*Phyllotheca Etheridgei*, sp. nov. After Etheridge. Nat. size.

The chief characters of this species are the short free teeth, and the sheath, clasping at the base, but expanding distally into an open and spreading disc-like structure.

Etheridge has compared this species with the genus *Cingularia*, Weiss, in the characters of the leaf-sheath. Zeiller[2] has already

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[1] Etheridge (95), p. 151. [2] Zeiller (02[1]), p. 31.

pointed out that the resemblance between Etheridge's plant and *Cingularia typica* is more apparent than real, in that the sheath in the latter spreads horizontally from the point of attachment, and is not contracted as in *Phyllotheca*. *Cingularia* is also distinguished by the characters of the fructification, which are entirely unknown in the case of Australian *Phyllotheca*, and consequently there are no good reasons for a close comparison between these two plants.

The Sedgwick Museum, Cambridge, has recently acquired some specimens of this interesting plant, and I have found that Mr. Etheridge's original description applies very closely, with the exception of the striæ of the sheath between the nerves, which the preservation in these specimens will not permit one to distinguish. The contracted lower portion of the sheath is, however, well seen. As Mr. Etheridge, jun., has not named this plant specifically, and as it appears to be distinct from other members of the genus, I have pleasure in calling it after him.

I agree with Zeiller,[1] who has suggested that the specimens with free leaves, which are also figured by Etheridge,[2] are not identical with this new species.

Known only from Shepherd's Hill, in the Newcastle Series of New South Wales.

Not represented in the British Museum collection.

7. **Phyllotheca Zeilleri,** Etheridge, jun.

1901. *Phyllotheca Zeilleri*, Etheridge, jun., in Anderson, 1st Rep. Geol. Surv. Natal, p. 72, pl. xiii, figs. 1–6.

Pith-casts articulate; internodes long, strongly ridged and grooved, 6 cm. or more in length; ridges and grooves continuous at the node, slightly convex, broad, delicately striate, with an average width of 1–1½ mm. Small scars occur in some specimens at the nodes between the costal endings and opposite the grooves. Leaf-sheath shallow, collar-like; free segments long, very narrow linear, acute, spreading, to the number of thirty, 2–7·5 cm. long.

The specimens on which Mr. Etheridge, jun., has founded this species are the best examples of *Phyllotheca* which have as yet

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[1] Zeiller (02[1]), p. 31.

[2] Etheridge (95), pl. xviii, figs. 4, 5.

been obtained from South Africa. Tate, Zeiller, and Seward have already indicated the occurrence of this genus in the Karoo Beds.

Mr. Etheridge has pointed out that the coarsely sulcate pith-casts of his species recall those of *Phyllotheca deliquescens* (Göpp.), and the specimens figured by McCoy as *P. Hookeri* (in part) which are now known to be identical with Göppert's species.[1] As, however, there may be some doubt as to the identity of the South African specimens with *P. deliquescens*, and as I have not had an opportunity of examining Mr. Etheridge's plant, I have retained his species for the present as distinct.

Known only from the Saint Lucia Bay Coalfield, Enselein River, Zululand.

Not represented in the British Museum collection.

8. **Phyllotheca,** sp. (from South Africa).

Tate[2] first recorded this genus from South Africa. Zeiller[3] has figured a *Phyllotheca* from Casey's Township in the Transvaal, which is not well enough preserved to admit of specific determination, and is of but rare occurrence. The leaves, of which only a few are preserved, are linear, almost filiform, and united at the base into a broadly open sheath. This plant appears to be distinct from *P. indica*, Bunb., and is probably a new species.

V. 3620. Figured by Seward (97[1]), p. 372, pl. xxiv, fig. 1; and (98[1]), p. 285, fig. 67.

This specimen shows several stems with narrow prominent internodal ridges, continuous at the node, but without leaves, which may also perhaps be assigned to this genus. In the absence of leaves it is almost impossible, as Mr. Seward has pointed out, to distinguish between stems or branches of *Phyllotheca* and *Schizoneura*. Mr. Seward has also concluded that a comparison of leaf-bearing stems of these two genera suggests a possibility that they might perhaps be both included under one generic name.

The larger fragment is 14 cm. long and 3·5 cm. broad, and

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[1] See Arber (02[1]), p. 17.

[2] Tate (67), p. 141, pl. v, fig. 6; and Feistmantel (89), p. 42.

[3] Zeiller (96[1]), p. 372, pl. xviii, figs. 5, *5a*.

shows three nodes and portions of four internodes. The smaller fragment measures 10 cm. by 3·5 cm. and shows two nodes.

From Maggie's Mine (Ecca Series), Middelburg District, Transvaal. *Presented by David Draper, Esq.*, 1897.

9. **Phyllotheca**, sp. (from South America).

Bodenbender[1] has recorded this genus from Argentina, but no particulars of the specimens are given.

Genus **ANNULARIA**, Sternberg, 1821.

[Flora Vorwelt, Heft ii, p. 32.]

Calamitean leaves, borne in whorls at the nodes of articulated branches, united into a sheath at the base; the free segments usually linear, spreading, and of unequal length.

[Annularia ?][2] **australis**, Feistmantel.

(Text-fig. 10.)

1866. ? *Asterophyllites*, Clarke, Quart. Journ. Geol. Soc., vol. xxii, p. 445.
1878. *Annularia australis*, Feistmantel, Palæontogr., Suppl. iii, p. 154, pl. vii, figs. 5–6*a*.
1883. *A. australis*, Tenison-Woods, Proc. Linn. Soc. New South Wales, vol. viii, p. 86.
1890. *A. australis*, Feistmantel, Mem. Geol. Surv. New South Wales, Pal., No. 3, p. 82, pl. xii, figs. 1, 2.
1891. *A. australis*, Etheridge, jun., Proc. Linn. Soc. New South Wales, ser. II, vol. v, p. 47, pls. ii, iii.

Type. ? Australian Museum, Sydney.

Feistmantel[3] has described this species as follows: — Stem slender, articulate; leaves whorled, as many as ten leaves in a whorl, incurved, spreading, membranaceous, lanceolate-spathulate up to 18 mm. in length, traversed by a median nerve.

The two specimens from Greta, New South Wales, figured by Feistmantel are very fragmentary. In 1891 Etheridge figured some more perfect specimens from Anvil Creek, which he compared

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[1] Bodenbender (96), table opposite p. 772.

[2] This generic name is placed in square brackets to imply that, in the author's opinion, the species may have to be transferred eventually to some other genus.

[3] Feistmantel (90[1]), p. 82.

with *Annularia stellata*, Schl. The whorls in these specimens are on an average 2 cm. apart, and most of them are twelve-leaved, but one or two have as many as twenty-four. The leaves are elongately lanceolate, and vary in length from 12 to 16 mm. Other specimens consisting of naked branched stems, articulated, and with longitudinal ridges on the internodes, are also figured.

Although Zeiller[1] has maintained the view that Feistmantel is correct in assigning this plant to the genus *Annularia*, it does not seem to me that this conclusion is free from doubt. It may be pointed out that the adoption of this genus, on what appears to be insufficient evidence, is a matter of some importance, since the presence of *Annularia*, a definite type of Calamitean foliage, with *Phyllotheca*, *Glossopteris*, and *Noeggerathiopsis*, in New South

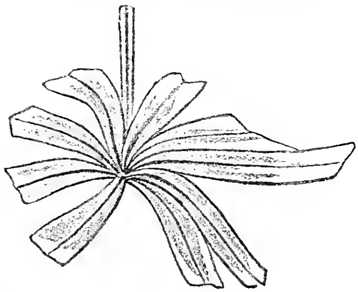

FIG. 10.—[*Annularia* (?)] *australis*, Feist. After Feistmantel. Nat. size.

Wales, implies that we have here an association of northern and southern types of Permo-Carboniferous plants. The absence, so far, of any trace of a Calamitean stem in these rocks is somewhat remarkable if the species in question is really the foliage of a Calamite. Judging by the figures published, the free lanceolate segments approximate more closely to leaf-whorls of certain Indian species of *Phyllotheca* (cf. *P. robusta*) than to *Annularia*. It is, however, difficult to come to any definite decision as to the genus to which the Australian species should be referred without seeing actual specimens, and these are unfortunately not represented in any British collection. I have, therefore, retained Feistmantel's generic name within square brackets, thus indicating that, while it

[1] Zeiller (86^2), p. 483.

is of a doubtful nature, there is not sufficient evidence to warrant the transference of this species to another genus at the present time.

This genus and species is known in the rocks of Gondwanaland only from the earliest *Glossopteris*-bearing beds in New South Wales at Greta and Anvil Creek, which are possibly equivalent to the Coal-measures of Europe. The genus is an abundant type of Calamitean foliage in the Northern Hemisphere in rocks of Upper Carboniferous and Permian age.

Not represented in the British Museum collection.

Genus **EQUISETITES,** Sternberg, 1833.

[Flora Vorwelt, Heft v, vi, p. 43.]

Equisetites is a somewhat unsatisfactory genus, including plants chiefly, but not entirely, of Mesozoic age, which closely resemble in habit the recent genus *Equisetum*, the Horsetails. It is almost impossible to distinguish clearly between the leaf-sheaths of *Equisetites* and such genera as *Annularia* and *Phyllotheca*. The chief foliage character is that the leaf-sheaths are large and prominent, and the free segments comparatively small. In many of the Mesozoic species, the sheath and the free leaves are closely appressed to the stem, and not spreading as in most Phyllothecas.

[Equisetites ?][1] **Morenianus,** Kurtz.

1894. *Equisetites Morenianus*, Kurtz, Rev. Mus. La Plata, vol. vi, p. 129, pl. iii, fig. 1.
1895. *E. Morenianus*, Bodenbender, Rev. Mus. La Plata, vol. vii, table opposite p. 148.
1896. *E. Morenianus*, Bodenbender, Zeitschr. deutsch. geol. Gesell., vol. xlviii, table opposite p. 772.

Type. La Plata Museum, Argentina.

Kurtz describes this species as follows: — Caule articulato, ramoso, striato, striis paucis fortioribus tenuioribus intermixtis notato; articulis subæqualibus, 1·5 – 1·7 cm. longis, 5–6 mm. latis; vaginis ramorum longe denticulatis, dentibus acutis.

The fragment figured by Kurtz is about 4 cm. long, and consists of a branched axis. The branch bears what are apparently leaves

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[1] See footnote, p. 30.

with funnel-shaped sheaths. The details are not clearly shown, and unless the specimen is itself very much better than the figure implies, the evidence is quite insufficient to refer this fragment to *Equisetites*, or indeed to any other genus. Judging by the figure, it might be equally well placed in the genus *Phyllotheca*. This determination must therefore remain doubtful for the present.

Known only from Argentina.

Not represented in the British Museum collection.

Obscure Articulated Casts.

V. 7597. This specimen shows what appears to be the impression of the woody tissues of a stem on either side of an articulated cast, some 6·5 cm. in length. At first sight it somewhat resembles a badly-preserved Calamitean pith-cast, as I have already pointed out elsewhere,[1] but it is doubtful if the preservation is sufficiently good to determine it even generically. There are no ridges or grooves to be seen on the internodes, nor any trace of branch or other scars. The internodes vary in length, and the nodal constrictions, if they really are of this nature, do not correspond with those of the impression of the woody tissues.

Tuli Coalfield, Rhodesia. *Pres. by A. J. C. Molyneux, Esq.*, 1901.

V. 3618. Figured by Seward (97[1]), p. 325, pl. xxii, fig. 4*b*. This specimen consists of a long, finely ribbed cast, 27 cm. in length, and 5·5 cm. in breadth. The grooves between the ribs are 1–1·8 mm. broad. There are no trustworthy indications of nodes. Mr. Seward has remarked that it is difficult to decide whether this specimen is a broad leaf with parallel veins, or a flattened stem-cast with long internodes. He inclines towards the latter conclusion, doubtfully comparing this specimen with stems of Calamites.

Vereeniging, Transvaal. *Pres. by D. Draper, Esq.*, 1897.

V. 3619. Figured by Seward (97[1]), p. 326, pl. xxiv, fig. 2. A long stem-cast, 26·5 cm. in length, and 2 cm. broad, with a strong transverse ridge near one end of the specimen, which possibly marks the position of a node. The precise nature of this fossil is very doubtful. Mr. Seward has compared it, with much

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[1] Arber (03), p. 289.

hesitation, to a Calamitean stem. Fronds of *Glossopteris* are associated.

Vereeniging, Transvaal. *Pres. by D. Draper, Esq.*, 1897.

V. 2418. Four specimens showing small fragments of Equisetalean stems.

Beaufort Series (?), East London, Cape Colony.

Class SPHENOPHYLLALES.

The characters of the class *Sphenophyllales* are those of the isolated genus *Sphenophyllum.* The Lower Carboniferous genus *Cheirostrobus* may perhaps be also included in this class.

Genus **SPHENOPHYLLUM,** Brongniart, 1822.

[Mém. Mus. d'Hist. Nat., vol. viii, pp. 209, 234.]

Plants with slender stems, possibly climbing plants of 'scrambling' habit; stems articulated, usually tumid at the nodes, internodes ribbed, ribs not alternating at the nodes. Branches arising occasionally at the node, but only one branch from any one node. Leaves whorled, often dimorphic, varying in length and shape, often cuneiform, entire, or much divided into linear segments. Leaves of the whorl equal, or unequal in size, usually, but not always, six, or some multiple of three in number, free from one another at point of attachment; successive whorls of leaves superposed. Cones long and narrow, terminal or lateral, composed of numerous bracts fused basally into a saucer-like collar round the axis, and bearing sporangia, either sessile or stalked, on their upper surface.

Brongniart originally described this genus under the name *Sphenophyllites,* which he later changed to *Sphenophyllum.*[1]

Sphenophyllum is a characteristic member of the Carboniferous and Permian floras of the Northern Hemisphere, but it also occurs in association with the Glossopteris flora in India and South Africa. The Indian species differs in certain respects from the majority of those occurring in Europe, especially in the fact that the leaves of the whorl are arranged in three pairs of unequal size. It was this

[1] Brongniart (28[1]), p. 68.

character which led Royle,[1] in his original description published in 1833, to institute a new genus, *Trizygia*, for its reception. There has since been some difference of opinion as to whether this conclusion should be maintained. M'Clelland,[2] in 1850, reverted to the generic title *Sphenophyllum*, while others, especially Feistmantel in his later memoirs, have adopted Royle's genus. In 1891, however, M. Bosniaski discovered specimens possessing the same characteristic arrangement of the leaves as the Indian species in the Carboniferous beds of Monte Pisano, and Professor Zeiller[3] has since pointed out that Sphenophyllums with all the generic characters of *Trizygia* occur both in the Coal-measures and the Permian. Consequently there seem to be no good reasons for retaining Royle's genus, and Mr. Seward and others have adopted Zeiller's conclusion.

1. Sphenophyllum speciosum (Royle).

(Pl. I, Figs. 1, 1*a*.)

1833. *Trizygia speciosa*, Royle, Illust. Bot. Himal. Mounts., p. xxix*, pl. ii, fig. 8.
1845. *T. speciosa*, Unger, Synopsis Plant. foss., p. 114.
1850. *Sphenophyllum speciosa*, M'Clelland, Rep. Geol. Surv. India, p. 54, pl. XIV, fig. 5.
S. trizygia, Unger, Gen. et Spec. Plant. foss., p. 71.
1860. *Sphenophyllum*, Oldham, Mem. Geol. Surv. India, vol. ii, pt. 3, p. 326.
1865. *Trizygia*, Blanford, Mem. Geol. Surv. India, vol. iii, pt. 1, p. 31.
1876. *Sphenophyllum trizygia*, Feistmantel, Rec. Geol. Surv. India, vol. ix, pt. 3, p. 70.
S. trizygia, Feistmantel, Journ. Asiat. Soc. Bengal, vol. xlv, pt. 2, p. 342, pl. xv, figs. 1, 2, 2*a*.
1879. *Trizygia*, Feistmantel, Rec. Geol. Surv. India, vol. xii, pt. 3, p. 163.
1880. *T. speciosa*, Feistmantel, Flora Gondw. Syst., vol. iii, pt. 3, p. 69, pl. xi A; pl. xii A, figs. 1, 1*a*, 2.
1882. *T. speciosa*, Feistmantel, Flora Gondw. Syst., vol. iv, pt. 1, p. 22.
1886. *T. speciosa*, Feistmantel, Flora Gondw. Syst., vol. iv, pt. 2, p. 22.
1891. *Sphenophyllum speciosum*, Zeiller, Bull. Soc. Géol. France, ser. III, vol. xix, p. 673.
1898. *S. speciosum*, Seward, Fossil Plants, vol. i, p. 411, text-fig. 111.
1900. *S. speciosum*, Zeiller, Élém. Paléobot., p. 110.
1901. *Trizygia*, Kidston, Trans. Nat. Hist. Soc. Glasgow, N.S., vol. vi, p. 129.
Sphenophyllum speciosum, Arber, Geol. Mag., dec. iv, vol. viii, p. 546.

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[1] Royle (33), p. xxix*.
[2] M'Clelland (50).
[3] Zeiller (91), p. 673.

Type. **V. 4190,** Geol. Dept. British Museum (Nat. Hist.).

Stem slender, articulated; internodes ridged. Leaves whorled, each whorl consisting of six leaves arranged in three pairs of unequal size, and successive whorls superposed. Leaves spreading, entire, always undivided, elongate-ovate, or ovate. Venation of the *Sphenophyllum* type.

V. 4190. Pl. I, Figs. 1, 1*a*. *Type.*

The type, which is here refigured, is a fine specimen, 15 cm. long and 6·3 cm. across, showing nine whorls of leaves. The stem is very slender, from 1 to 1·5 mm. broad. The internodes bear two fairly prominent ridges, but the preservation is not sufficiently good to determine whether these ridges are continuous at the node. Two pairs of leaves in the whorl are elongate-ovate, entire and spreading, each member being about 2·8 cm. long by 9 mm. broad, the smaller pair, 16 by 9 mm., are ovate and reflexed. The veins are distinct, somewhat distant; usually two veins enter the leaf at the base and spread with frequent branching throughout the lamina.

In the type-specimen the two longer pairs of leaves in the whorl appear to be of approximately equal size. In other specimens,[1] however, all the three pairs are dissimilar in length. Feistmantel states that the leaves are arranged unsymmetrically at the node, and not radially disposed. It is difficult, however, to ascertain with certainty whether this is really the case in the type-specimen, although it may possibly be true of other examples.

There would seem to be no real evidence in support of Feistmantel's[2] view that this plant was an aquatic; a view based on the disproportionate size of the leaves to the axis. We may rather regard the Indian species as a climbing plant of the 'scrambler' habit, like other Sphenophyllums.

Sphenophyllum speciosum is known only from the Barákar and Raniganj groups of the Damuda division of India.

2. Sphenophyllum, sp. (from South Africa).

V. 3132, V. 7583. Text-fig. 11.

This specimen consists of the two halves of a piece of shale

[1] Feistmantel (80), p. 70.

[2] Feistmantel (80), p. 69.

from Natal, on which occur numerous fronds of *Glossopteris*. In addition, there is a small and imperfect fragment (Text-fig. 11), which is in all probability referable to *Sphenophyllum*, a genus which so far has not been found in South Africa. The plant appears to consist of a whorl of leaves, the basal portions of five leaves being seen, which seem to be united into a short sheath

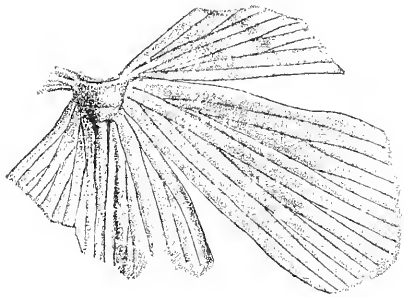

FIG. 11.—*Sphenophyllum*, sp. V. 7583. × 3.

at the base. The leaves are wedge-shaped, and have a typical *Sphenophyllum* nervation, there being apparently two main nerves at the base, though the details are not very clear in this region. The apices of the leaves are not seen, but from their shape and nervation there would appear to be little doubt that they should be referred to this genus.

Natal. *Presented by the Natal Government*, 1897.

Class FILICALES (?).

The members of the class Filicales are characterised by small stems in comparison with the size of the leaves. Leaves often deeply divided. The fertile fronds are either identical in form with the sterile leaves, or more or less highly modified. The numerous sporangia are usually isosporous, though in a few genera heterosporous, and are arranged in sori. The archesporium arises most frequently from a single cell.

The genera *Glossopteris*, *Gangamopteris*, *Neuropteridium*, and others described here have a fern-like habit, and have been usually regarded as true ferns. In the majority of cases, however, their

fructifications are quite unknown, and they cannot be referred to any families of recent Filicales. It would perhaps be best to speak of them for the present under the more non-committal designation of Fern-like Plants.

Genus **GLOSSOPTERIS**, Brongniart, 1822.

[Mém. Mus. d'Hist. Nat., vol. viii, p. 232.]

Fronds often dimorphic, borne on rhizome-like structures (*Vertebraria*). The larger fronds simple, entire, sessile, petiolate, or contracted at the base to a short petiole. Size and shape greatly varied. Spathulate, lanceolate, ovate, linear, etc. Apex obtuse, acute, or emarginate. Midrib well-marked, extending to the apex, or impersistent. Secondary nerves numerous, more or less arched, dividing by dichotomy, and anastomosing to form a network, the meshes of which are polygonal, and more or less elongate. The smaller fronds or scale-fronds varied in size and shape, strongly concave, as regards nervation similar to the larger fronds, but without a midrib. Fructification not known, at present, quite beyond doubt.

The more important characters by which *Glossopteris* may be recognised are the simple, entire fronds with a midrib (cf. *Gangamopteris*), and the anastomosing and dichotomising secondary nervation.

Glossopteris was defined by Brongniart in 1828 [1] as follows:—"Fronde simple entière, plus ou moins lancéolée, rétrécie insensiblement ver sa base; nervure moyenne large à sa base, s'évanouissant vers le sommet, et donnant naissance à des nervures secondaires, fines, arquées, oblique, dichotomes, quelquefois anastomées à leur base." The large number of fronds of *Glossopteris* which have since been described from India and elsewhere in Gondwanaland, have, however, considerably modified this generic diagnosis, and a more extended definition has been adopted here. In particular, the fronds of almost all the known species of *Glossopteris* possess a reticulate secondary nervation throughout the entire lamina, and are not, as Brongniart thought, reticulate only near their point of origin from the midrib.

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[1] Brongniart (28^1), p. 54.

Feistmantel and many other authors have described numerous forms of Glossopterid fronds from India, Australia, and South Africa, but it is only within the last few years that we have come to know anything of the general habit and characteristics of this plant. Zeiller[1] especially has greatly added to our knowledge in this respect. He was the first to point out that the fossils, long known as *Vertebraria*, are the rhizomes of *Glossopteris*, a discovery which was made independently, and almost simultaneously by Oldham. Zeiller has also offered a more satisfactory explanation of the morphological features of these impressions,[2] and to him we owe the discovery of the dimorphic nature of the fronds.

Until quite recently we have been without reliable evidence as to one important character, the fructification. It may, perhaps, be worth while considering in some detail the evidence which has been put forward so far on this subject.

Distribution.—Permo-Carboniferous (Glossopteris flora) :—India, in the Talchir and Damuda divisions; Persia; New South Wales, in the "Lower Coal Measures" and Newcastle Series; Queensland; Western Australia; Tasmania; Cape Colony; Natal; Transvaal; Orange River Colony; Rhodesia; German and Portuguese East Africa; Argentina. *Permian* (Northern Type) :—Russia. *Triassic* :—India (Panchet division); Tonquin; China.

THE FRUCTIFICATION OF *GLOSSOPTERIS*.

Glossopteris has been almost universally regarded as a fern on account of the similarity of habit which exists between the larger fronds and those of such recent genera as *Drymoglossum*, *Acrostichum*, among others, rather than from any knowledge of the fructification. It may be stated at once that until the present year (1905) the sporangia of this plant have not been recognised. The fronds, which have been figured by various authors as exhibiting characters indicative of the position of the sori, are not free from the doubt that these features may, after all, be capable of a different explanation. Consequently the systematic importance

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[1] Zeiller (96^3).

[2] Zeiller (96^1).

of such characters, on which stress has been laid by Feistmantel and other authors, is extremely doubtful.

Attention has been called to specimens of several different types, which have been believed to indicate the position of sori. Carruthers [1] stated that, on some fronds from Queensland, there were indications of "linear sori running along the veins." It is hardly conceivable, however, that if such sori existed they would not have been recognised long ago in some of the beautifully preserved specimens which have been examined.

There also appears to be no real evidence for the view expressed by Feistmantel,[2] on very untrustworthy grounds, that a marginal fructification occurs in the case of *Glossopteris angustifolia*.

Numerous examples of the larger fronds have been figured in which circular or oval spots, patches, or holes in the lamina have been found, arranged in a manner more or less parallel with the midrib. These have been interpreted as probably indicating the position of sori by Brongniart,[3] Bunbury,[4] Feistmantel,[5] David,[6] Mitchell,[7] and Zeiller.[8] Mr. Seward [9] has re-examined Bunbury's specimens, and described specimens similar to those figured by Zeiller, and has expressed himself as very doubtful whether any reliable conclusions can be drawn from such imperfect evidence. In the light of a recent discovery, there is now a strong presumption that the great majority of the larger fronds of *Glossopteris*, such as have been figured by these authors, were sterile, and not fertile fronds.

A full account of the discovery alluded to has been recently published elsewhere,[10] but a brief description of the sporangium-like organs of *Glossopteris* may be included here.

During the examination of the British Museum collection in the preparation of this catalogue, a few specimens from New South Wales were found, showing excellent examples of the scale-fronds

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1 Carruthers (72), p. 354.

2 Feistmantel (80), p. 106, pl. xxxix A, figs. 1, 1*a*, 2.

3 Brongniart (28^2), p. 224, pl. lxii, fig. 2.

4 Bunbury (61), p. 327, pl. viii, fig. 1.

5 Feistmantel (80), pp. 97–8, 101, pl. xxvi A, figs. 1–4; pl. xxvii A, figs. 1, 2, 5; and (82^1), p. 32, pl. xxi, figs. 13–14.

6 David (91), pp. 424–5.

7 Mitchell (93), p. 377 and fig.

8 Zeiller (96^1), p. 369, pl. xviii, figs. 3, 3^1.

9 Seward (97^1), p. 320, pl. xxi, fig. 1; (97^2), p. 180.

10 Arber (05).

of *Glossopteris.* Associated with these scale-fronds it was noticed that groups of minute bodies, almost invisible to the naked eye, frequently occurred. On microscopic examination it was discovered that these bodies were sac-like structures of peculiar form, often beautifully preserved, although not unfortunately in the petrified state. A few further specimens have since been found in the collections at Cambridge, and on this material it has been possible to show that, in all probability, these sac-like organs are the sporangia of *Glossopteris Browniana.*

FIG. 12.—Sporangium-like organs of *Glossopteris Browniana*, Brong. V. 7202. × 30.

These organs occur in groups, which suggest a comparison with the sori of ferns. They are somewhat elliptical in shape, tapering at either extremity (Text-figs. 12 and 13). They measure 1·2–1·5 mm. along the major, and ·6–·8 mm. along the minor axis.

In many examples one end of the sac-like body is prolonged into a short, bent neck; the whole organ having thus the appearance of a retort. The cell-walls of the outer layer of the sac are extremely characteristic, the cells being rhombic in shape, and much longer than broad (Text-fig. 13). The cell-walls of the inner layer are much less conspicuous (Text-fig. 14).

These organs are sac-like structures, and dehisced longitudinally. Their contents have not, however, been recognised, but from

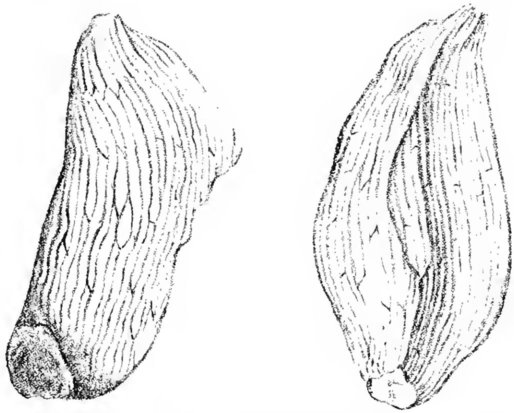

Fig. 13.—Sporangium-like organs of *Glossopteris Browniana*, Brong. V. 7202 and V. 7211. × 35.

a number of considerations there is little doubt that they were of the nature of spores, and the sacs themselves sporangia.

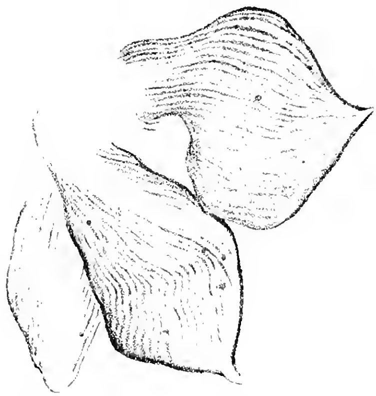

Fig. 14.—Sporangium-like organs of *Glossopteris Browniana*, Brong., which have dehisced, viewed from the inner surface. 39,149. × 30.

There can hardly be any hesitation in attributing these sporangium-like organs to *Glossopteris Browniana*. They have never been

observed except in close relationship to the scale-fronds of that fossil, and are not found associated with the larger fronds alone. This fact probably explains why they have not been already discovered. In addition, there is a certain amount of evidence which goes to show that these sac-like bodies were in all probability attached in groups by the neck-like extremity to the scale-fronds. Text-fig. 15 shows the concave surface of a fragment of a scale-frond, bearing oval scars, probably the prints of sori, and fragments of the sporangium-like bodies still apparently attached. The

FIG. 15.—A scale-frond showing the scars of attachment of the sporangium-like organs, and fragments of the sac-like bodies still apparently in continuity. V. 7202. × 30.

absence of any trace of a rhizome (*Vertebraria*) in association with these organs, or of any suggestion of a strobilus-like arrangement, strengthens this conclusion.

Although spores have not been recognised within these sac-like bodies, the latter may be so closely compared with the sporangia of certain recent and extinct plants that little doubt remains as to their true nature. In size, and in some points in their structure, they are not unlike the sporangia of *Sphenophyllum*, and, in the latter respect, the sporangia of *Discopteris Ralli*, Zeill. A closer

comparison, however, may be found in the microsporangia of a Cycad such as *Stangeria*, which they closely resemble in size, shape, and mode of dehiscence.

If these bodies are really of the nature of sporangia, then *Glossopteris* cannot be included within any family of the recent ferns, although it may have belonged to that group. Thus the affinities of this genus are still uncertain.

Specimens showing the Sporangium-like Organs of Glossopteris Browniana.

V. 7202. Text-figs. 12, 13, and 15.

A nearly square piece of pinkish shale showing several of the larger fronds of *G. Browniana*, and on one side several good specimens of the scale-fronds. The largest of these measures 1·7 cm. long, and is about 1 cm. across at its widest part. Like the other examples, it is tinged a blue colour, which is a natural feature. A large number of detached sporangium-like bodies occur near this scale-frond, enlarged drawings of which are given in Text-figs. 12 and 13. Smaller fragments of the scale-fronds also occur, and one of these (Text-fig. 15) is particularly interesting, since it shows several oval scars, possibly the prints of attachment of the sori, and fragments of the sac-like bodies still apparently in continuity. Elsewhere on the same specimen numerous detached sacs occur, and similar but less clear examples of scale-fronds showing what are possibly the prints of sori.

Port Stephens, New South Wales. *Odinheimer Coll.*

V. 7211. Pl. II, Figs. 4 and 5, Text-fig. 13.

A triangular piece of shale, similar to the last specimen, showing a considerable number of the scale-leaves, which are triangular in shape and strongly convex (Pl. II, Figs. 4 and 5). An average specimen measures 1·5 cm. long, and ·6 cm. across. A few fragments of the larger fronds also occur. Several well-preserved examples of the detached sporangium-like bodies are found, of which one is shown in Text-fig. 13. The cell-walls of the outer limiting layer of these sacs are very conspicuous. There is also some evidence of prints of sori on some of the smaller fragments of the scale-fronds.

Port Stephens, New South Wales. *Odinheimer Coll.*

39,149. Text-fig. 14.

Another and similar piece of pinkish scale, on which occur impressions, chiefly of the larger fronds of *G. Browniana*. There are also a fairly good example of a strongly convex scale-frond, and a few more fragmentary specimens of the same leaves on which prints of sori may possibly occur. Two groups of the sporangium-like organs are found, as well as other more obscure examples. Some of these have dehisced (Text-fig. 14), while others again are arranged in a sorus-like manner.

Port Stephens, New South Wales. *Odinheimer Coll.*

SPECIES OF *GLOSSOPTERIS*.

A large number of species of *Glossopteris* have been described by various authors, in many cases on quite insufficient grounds. It is a most difficult and thankless task to attempt a general revision of these specific determinations, for it is almost impossible to obtain any definite aggregate of characters to serve as a standard in dealing with details confined to the shape of the sterile frond and its nervation; the characters on which any classification must at present be based. There has been considerable difference of opinion already on this subject. In 1828, Brongniart [1] described an Indian and an Australian leaf, which he regarded as varieties of a species to which he gave the name *Glossopteris Browniana*. Some years later Schimper [2] raised both these forms to specific rank, as *G. Browniana* and *G. indica* respectively. Since then Feistmantel, especially, has described many fronds as new species, some of which, such as *G. communis*, are now admitted to be unworthy of separate designations. In more recent times Professor Zeiller [3] has upheld in several cases the specific rank of certain fronds which Mr. Seward [4] has been inclined to regard as hardly more than varieties.

The difficulty arises from the fact that, as in other fern-like plants both recent and extinct, there existed a considerable variation in the form and shape of the leaf of *Glossopteris*, and in the details of the nervation, even in fronds which there is reason

[1] Brongniart (28²), p. 223.

[2] Schimper (69), p. 645.

[3] Zeiller (96²), (02¹).

[4] Seward (97¹).

to believe belonged to the same plant. Some degree of variation in these characters has been admitted by all. Bunbury,[1] one of the earliest writers on the Indian Glossopterids, has called attention to the fact, and in more recent times Professor Zeiller and Mr. Seward have given further illustrations.

Indeed, a detailed examination shows that there are hardly any characters which may be regarded as constant in fronds of the same species. Size and shape are admittedly dangerous guides, and it would seem almost certain that some of the narrower fronds may have been borne on the same rhizome as those of broader dimensions.

The characters of the midrib, its thickness, its persistence or non-persistence at the apex, and the obtuse or acute termination of the leaf are often simple corollaries of the size and shape of the frond. The angle of divergence of the secondary veins from the midrib is quite untrustworthy, and frequently varies in different parts of the same frond, and on opposite sides of the midrib (Text-figs. 16, 17, and 19). The one character which does appear to be fairly constant, though it is by no means without a certain amount of variation, is the average openness or closeness of the secondary nerves, and consequently the shape of the meshes or areoles.

In attempting a general revision of this large genus, the choice lies between grouping broadly, and distinguishing in detail. Whatever classification may be adopted must necessarily be an artificial one, until we know more of the fructification of the different types of frond. Since an artificial classification is without alternative, and seeing that the value of such a classification depends largely on its convenience, it would seem more convenient, as well as more in accordance with our knowledge of the variations in the details of the fronds of this genus, to maintain comparatively few species, and to group together those fronds which, though they may differ in one or more details from the typical form, are not sufficiently dissimilar in the aggregate of their characters to warrant separate specific rank. Some authors have expressed this view by distinguishing a number of varieties or

[1] Bunbury (61), p. 327.

subspecies. It is to be doubted whether there is any real gain in so doing, when the classification is necessarily artificial. The shorter, and less cumbersome name is an argument in favour of maintaining only specific rank.

In the present instance, I have endeavoured to group together these fronds as broadly as possible, and without distinction of subspecies or varieties. In this manner, it has been possible to reduce the number of specific determinations to thirteen. This classification is not by any means to be regarded as final. Although a large number of species have been founded, especially by Feistmantel, often on too fragmentary evidence, or on the occurrence of a single example, which are not recognised here, it is quite possible that, in some cases, the discovery of further, or better preserved evidence may be sufficient to establish their specific rank. In many instances, it has been a matter of the greatest difficulty to decide whether a certain frond is sufficiently distinct to warrant separation, especially as, in the great majority of cases, no examples of the rarer specimens, previously determined by other authors, are available for comparison in any museum in this country.

Synopsis of Species of Glossopteris.

I. Type of *Glossopteris Browniana*. Meshes of medium breadth, or narrowly elongate, midrib persistent.

(1) Leaves spathulate, sub-oval, or linear; obtuse; meshes of medium breadth.
1. *G. Browniana*, Brong.

(2) Leaves lanceolate, or linear; acute, or acuminate.

α. Meshes very narrow, elongate, not as a rule markedly broader on the borders of the midrib than in the rest of the lamina.

Frond large, elongate-lanceolate or oval-lanceolate.
2. *G. indica*, Schimper.

Frond of medium size, narrow, linear. 3. *G. angustifolia*, Brong.

β. Meshes very narrow, elongate, except on either side of the midrib, where they are comparatively broad and polygonal.

Frond large, lanceolate. 4. *G. stricta*, Bunb.

(3) Leaves large, broadly obovate, obtuse, or emarginate; midrib thick, nerves very close and subparallel, and meshes narrow, except near the midrib. 5. *G. ampla*, Dana.

II. Type of *Glossopteris retifera*. Meshes very broad, midrib persistent.

Frond of medium size, lanceolate or oval-lanceolate. Meshes not much longer than broad. 6. *G. retifera*, Feist.

Frond fairly large, spathulate or oval-lanceolate. Meshes elongate-polygonal, much longer than broad. 7. *G. conspicua*, Feist.

Frond linear. Meshes broad, oblong-polygonal. 8. *G. formosa*, Feist.

III. Type of *Glossopteris tortuosa*. Lateral nerves sinuate, or tortuous.

Frond fairly narrow. Meshes on either side of the midrib large, broadly polygonal, the succeeding meshes narrower, elongate-polygonal or trapezoidal. 9. *G. tortuosa*, Zeiller.

Frond fairly broad. Meshes broad, irregular, of nearly equal size throughout the lamina and very elongate. 10. *G. divergens*, Feist.

IV. Type of *Glossopteris decipiens*. Midrib impersistent in the upper portion of the frond, at a considerable distance from the apex.

Frond narrowly spathulate, truncated at the base. Meshes narrow, oblong. 11. *G. decipiens*, Feist.

Frond oblong-oval, petiolate. Meshes broad, oblong. 12. *G. longicaulis*, Feist.

V. Type of *Glossopteris orbicularis*. Fronds orbicular, subemarginate. Meshes broad, oblong-polygonal. 13. *G. orbicularis*, Feist.

Fronds and Scale-fronds of Glossopteris.

1. Glossopteris Browniana, Brongniart (pars).

(Pl. II, Figs. 1–5; Pl. III, Figs. 1, 2; Text-fig. 16.)

1828. *Glossopteris Browniana*, Brongniart (pars), Prodr. Hist. Végét. foss., p. 54.

1830. *G. Browniana*, var. *australasica*, Brongniart, Hist. Végét. foss., p. 223, pl. lxii (pars).

1836. *G. Browniana*, Goeppert, Die Foss. Farn., p. 346, pl. xxi, figs. 9, 10.

1845. *G. Browniana*, Morris, in Strzelecki's New South Wales, p. 247, pl. vi, figs. 1, 1*a*.

1847. *G. Browniana*, McCoy, Ann. & Mag. Nat. Hist., vol. xx, p. 150.
G. linearis, McCoy, ibid., p. 151, pl. ix, figs. 5, 5*a*.

1849. *G. Browniana*, Dana, in Wilkes' U.S. Explor. Exped., vol. x, pp. 716, 717, pl. xii, fig. 13*a*, and ? figs. 13, 13*b*, 13*c*.
G. elongata, Dana, ibid., p. 718, pl. xiii, fig. 4.
G. reticulum, Dana, ibid., p. 717, pl. xiii, fig. 2.
G. linearis, Dana, ibid., p. 718.

1850. *G. Browniana*, Unger, Gen. et Spec. Plant. foss., p. 169.
G. linearis, Unger, ibid., p. 169.

1861. *G. Browniana*, var. *australasica*, Bunbury, Quart. Journ. Geol. Soc., vol. xvii, p. 329, pl. viii, fig. 5.

1867. *G. Browniana*, Tate, Quart. Journ. Geol. Soc., vol. xxiii, p. 140, pl. vi, figs. 5*a*, 5*b*, 7*a*, 7*b*.
G. Sutherlandi, Tate, ibid., p. 140, pl. vi, figs. 2*a*, 2*b*.

1869. *G. Browniana*, Schimper, Traité, vol. i, pp. 645, 646.

1872. *G. Browniana*, Carruthers, Quart. Journ. Geol. Soc., vol. xxviii, p. 354.

1876. *G. Browniana*, Feistmantel, Rec. Geol. Surv. India, vol. ix, pt. 3, p. 72.

1878. *G. Browniana*, Feistmantel, Palæontogr., Suppl. iii, pp. 78, 90, 154, pl. viii, figs. 3, 3*a*, 4; pl. x, figs. 1, 3, 4, 5, 7; pl. xi, fig. 1; pl. viii (xxvi), fig. 1.

? *Glossopteris elongata*, Feistmantel, ibid., p. 92.
G. reticulum, Feistmantel, ibid., p. 92.
? *G. Clarki*, Feistmantel, ibid., p. 79, pl. v, figs. 4, 4*a*.
? *G. parallela*, Feistmantel, ibid., p. 93, pl. ix, figs. 2–4.
G. linearis, Feistmantel, ibid., pp. 91, 150, pl. viii, figs. 1–2 ; pl. xi, figs. 3–4 ; pl. xii, fig. 4.
G. Browniana, var. *præcursor*, Feistmantel, ibid., p. 79, pl. v, figs. 5–7.
G. Wilkinsoni, Feistmantel, ibid., p. 92, pl. xiii, figs. 1, 1*a*.
G. Browniana, Etheridge, jun., Cat. Australian Foss., p. 30.
1880. *G. Browniana*, Feistmantel, Flora Gondw. Syst., vol. iii, pts. 2–3, p 102, pl. xxvi A, fig. 2 : pl. xxvii A, fig. 2 ; pl. xxix A, figs. 1, 2, 3, 6, 8 ; pl. xl A, fig. 5.
G. intermittens, Feistmantel, ibid., p. 99, pl. xxxiii A, figs. 4, 4*a*.
1882. *G. Browniana*, Feistmantel, Flora Gondw. Syst., vol. iv, pt. 1, p. 34, pl. xii, fig. 4 : pl. xx, fig. 3.
? *G. cordata*, Feistmantel (*non* Dana), ibid., p. 34, pl. xx, fig. 1.
1883. *G. Browniana*, Tenison-Woods, Proc. Linn. Soc. New South Wales, vol. viii, p. 122.
G. reticulata, Tenison-Woods, ibid., p. 124.
? *G. Clarkei*, Tenison-Woods, ibid., p. 126.
? *G. parallela*, Tenison-Woods, ibid., p. 125.
? *G. elongata*, Tenison-Woods, ibid., p. 124.
G. linearis, Tenison-Woods, ibid., p. 123.
G. Browniana, var. *præcursor*, Tenison-Woods, ibid., p. 126.
G. Wilkinsoni, Tenison-Woods, ibid., p. 125.
1886. *G. Browniana*, Feistmantel, Flora Gondw. Syst., vol. iv, pt. 2, p. 28, pl. i A, figs. 2, 2*a*.
G. Browniana, Johnston, Papers & Proc. R. Soc. Tasmania for 1885, p. 376.
G. elongata, Johnston, ibid., p. 376.
G. reticulata, Johnston, ibid., p. 377.
G. linearis, Johnston, ibid., p. 377.
G. Browniana, var. *præcursor*, Johnston, ibid., p. 377.
G. parallela, Johnston, ibid., p. 378.
G. Clarkei, Johnston, ibid., p. 379.
1887. ? *G.* (?) *moribunda*, Johnston, Papers & Proc. R. Soc. Tasmania for 1886, p. 169.
1888. *G. Browniana*, Johnston, Geol. Tasmania, pp. 111, 134, pl. ix, fig. 1.
1889. *G. Browniana*, Feistmantel, Abhand. böhm. Gesell. Wiss. Prag, ser. VII, vol. iii, pp. 36, 43, pl. iv, fig. 4.
1890. *G. Browniana*, Feistmantel, Mem. Geol. Surv. New South Wales, Pal. No. 3, p. 121, pl. xiii, fig. 1 ; pl. xvi, figs. 3, 4 ; pl. xvii, figs. 1, 3, 4, 5 ; pl. xx, fig. 2.
G. Browniana, var. *præcursor*, Feistmantel, ibid., p. 122, pl. xiii, figs. 5, 6.
G. Wilkinsoni, Feistmantel, ibid., p. 128, pl. xx, figs. 1, 1*a*.
G. reticulum, Feistmantel, ibid., p. 127.

Glossopteris linearis, Feistmantel, ibid., p. 126, pl. xvi, figs. 1, 2; pl. xix, figs. 3, 4; pl. xx, fig. 6.
? *G. Clarkei*, Feistmantel, ibid., p. 123, pl. xiii, figs. 4, 4*a*.
G. gangamopteroides, Feistmantel, ibid., p. 125, pl. xx, fig. 4.
? *G. parallela*, Feistmantel, ibid., p. 126, pl. xviii, figs. 2–4.
? *G. elongata*, Feistmantel, ibid., p. 125.
G. Browniana, Zittel, Handb. Palaont., pt. ii, p. 134, fig. 108.
1892. *G. Browniana*, Jack & Etheridge, Geol. & Pal. Queensland, p. 193, pl. xvi, fig. 8; pl. xvii, figs. 9, 10.
G. linearis, Jack & Etheridge, ibid., p. 194, pl. xviii, fig. 14.
G. Browniana, Johnston, Papers & Proc. R. Soc. Tasmania for 1891, p. 12.
1896. *G. Browniana*, Zeiller, Bull. Soc. Géol. France, ser. III, vol. xxiv, p. 362, text-figs. 8–10; pl. xvi, figs. 1–14.
1897. *G. Browniana*, Seward, Quart. Journ. Geol. Soc., vol. liii, p. 318, pl. xxi, fig. 1; pl. xxii, fig. 4*c*; pl. xxiii, fig. 1.
? *G. rectinervis*, Dun, Rec. Geol. Surv. New South Wales, vol. v, pt. 2, p. 64, pl. ix, figs. 1–3.
1899. *G. Browniana*, Potonié, Lehrb. Pflanzenpal., p. 155, fig. 154.
1900. *G. Browniana*, Zeiller, Élém. Paléobot., p. 113, fig. 86*a*.
G. Browniana, Potonié, in Deutsch. Ost-Afrika, vol. vii, p. 496.
1902. *G. Browniana*, Arber, Quart. Journ. Geol. Soc., vol. lviii, p. 5.
G. Browniana, var. *australasica*, Shirley, Bull. 18, Geol. Surv. Queensland, p. 13.
G. Browniana, Shirley, ibid., p. 12.
G. Browniana, var. *præcursor*, Shirley, ibid., p. 12.
? *G. parallela*, Shirley, ibid., p. 13.
G. Wilkinsoni, Shirley, ibid., p. 13.
1903. *G. Browniana*, Arber, Quart. Journ. Geol. Soc., vol. lix, p. 288.
1904. *G. Browniana*, Seward, in 2nd Rep. Geol. Surv. Natal, p. 98, pl. iv, fig. 1.

Scale-fronds of Glossopteris Browniana.

1847. *Glossopteris Browniana*, McCoy, Ann. & Mag. Nat. Hist., vol. xx, p. 151.
1896. *G. Browniana*, Zeiller, Bull. Soc. Géol. France, ser. III, vol. xxiv, p. 365, pl. xvi, figs. 6–14, and 6*a*, 9*a*, 10*a*, 11*a*, 13*a*, 14*a*.
1897. *G. Browniana*, Seward, Quart. Journ. Geol. Soc., vol. liii, p. 318, pl. xxiii, fig. 1.
1900. *G. Browniana*, Zeiller, Élém. Paléobot., p. 113, fig. 86*b*.
1904. *G. Browniana*, Seward, in 2nd Rep. Geol. Surv. Natal, p. 100, pl. iv, figs. 5–6.

Types. Oxford University Museum, and Museum of the Geological Society of London (on the authority of Brongniart).

Fronds of medium size, but greatly varied in both size and shape. Shape spathulate, oval-linear, linear, sub-oval, or almost oblong.

Apex obtuse, rounded, or obtusely pointed. Frond usually somewhat contracted at the base, or more rarely only very slightly contracted. Midrib broad, extending to the apex, or breaking up into fine reticulations at a short distance before reaching the apex. Secondary nerves generally arched, more rarely oblique, reaching the margin at an open angle. The obliquity of the nervation varies greatly even in portions of the same frond, and the size of the meshes also varies considerably. The network is as a rule fairly open, the meshes being polygonal, or elongate-polygonal.

Glossopteris Browniana varies greatly in size, shape, and in the details of the nervation. An average spathulate frond measures between 13 and 15 cm. in length. Other fronds are as small as

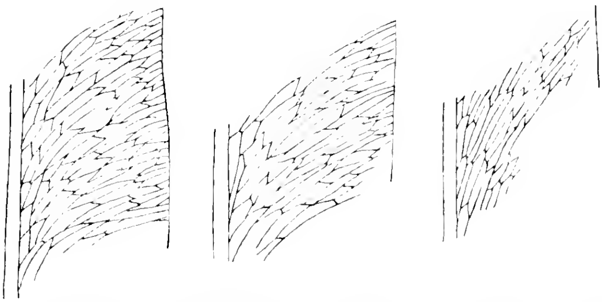

FIG. 16.—*Glossopteris Browniana*, Brong. Nervation of fronds from Australia. After Zeiller. × 2.

2 5 cm. long. Schimper[1] has called attention to the variety in the form and shape of these fronds. More recently Zeiller[2] has studied in detail the variation in the nervation, variations which he regards as individual and non-specific. He has pointed out that the midrib is not always found to be present at the base of the frond, but that it may be replaced by a group of parallel nerves, in this respect recalling *Gangamopteris*. The obliquity of the secondary nerves and the breadth of the meshes also vary greatly (Text-fig. 16). The meshes may be fairly broad and almost equal in size, or broader in the neighbourhood of the midrib. Or they may be narrow, and approximately of equal size throughout.

[1] Schimper (69), vol. i, p. 646.
[2] Zeiller (96^1), p. 362, figs. 8–10.

The characters which chiefly distinguish *G. Browniana* from other species are the spathulate, linear, or approximately oval shape, the obtuse apex, and the fairly open network with polygonal meshes.

The fronds of *G. Browniana* appear to be much more abundant in Australasia than in India. In New South Wales, especially, this species is far more common than any other, and every gradation in size and shape, from small linear fronds barely more than 2·5 cm. in length to leaves of spathulate or sub-oval form, as much as 15 cm. long, may be found, often on the same slab of shale. There are several specimens in this collection which are worthy of study in connection with these variations. Some of the smaller fronds are doubtless immature leaves which have not reached their full development. In any case it appears to me to be impossible to distinguish clearly between the smaller and the larger fronds. For this reason I have included under the name *G. Browniana* the smaller, narrower, and more linear fronds, similar to that first described by McCoy[1] as *G. linearis*, of which the type-specimen is preserved in the Sedgwick Museum, Cambridge.

Glossopteris Browniana was first described by Brongniart in 1828. Two years later he figured under this name two varieties which he termed *Glossopteris Browniana*, var. *australasica*, and *G. Browniana*, var. *indica*. In 1869 Schimper raised the Indian form to specific rank as *G. indica*, Schimper, and the name *G. Browniana* is now confined to fronds with a more open network, i.e. the variety *australasica* of Brongniart.

It should be noticed that Brongniart's[2] original figure of this species is incorrectly drawn, as Feistmantel has already pointed out. The secondary veins anastomose quite to the margin of the frond.

Feistmantel[3] has figured a fragmentary frond from the Raniganj group of the South Rewah Coalfield, India, as *G. cordata*. Only a single specimen is known, and this appears to have had a cordate base, and sub-auriculate basal lobes. It is questionable whether these characters are not imaginary rather than real, since the lower portion of the frond is manifestly fragmentary and imperfect. In any case Feistmantel's specific name is inadmissible, since it had

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[1] McCoy (47), p. 151, pl. ix, figs. 5, 5*a*.
[2] Brongniart (28²), pl. lxii, fig. 1.
[3] Feistmantel (82¹), p. 34, pl. xx, fig. 1.

been previously used by Dana. For the present this specimen is best regarded as a frond of the type of *G. Browniana*.

The fronds figured by Feistmantel[1] as *G. intermittens* do not appear to be worthy of separate specific rank. Zeiller has already referred one of them to *G. Browniana*, and it seems to me that possibly the others are indifferently preserved specimens of one of the commoner Indian fronds.

It may be also pointed out that the very small and imperfect fragments figured by Feistmantel[2] as types of a new species, which he called *G. ingens*, are utterly worthless as evidence even for generic determination. Among the Australian fronds of *Glossopt ris* named specifically by Feistmantel, there are several which would seem to fall within the limits of *G. Browniana* as defined here, if we bear in mind the great variations known to occur among these fronds. *G. Clarkei*, Feist.,[3] a leaf from Rix's Creek, New South Wales, on the lower horizon of *Glossopteris*-bearing rocks in that colony, with meshes very long next the midrib, but much shorter towards the margin, appears to differ only in this particular from the other linear forms included here under that species.

Glossopteris gangamopteroides, from the Newcastle Series of New South Wales, is another of Feistmantel's species,[4] which, judging from his description and figure, cannot be clearly distinguished from *G. Browniana*.

The fronds named by Feistmantel[5] *Glossopteris parallela*, from Bowenfels, New South Wales, may perhaps be also included as large leaves of *Glossopteris Browniana*, on account of the general similarity in the nervation. As Feistmantel remarks, the secondary nerves appear to be generally parallel, but this would seem to be insufficient to warrant separation, since the same feature is sometimes observed in undoubted fronds of the latter species.

It is possible that if further and more complete specimens of this

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[1] Feistmantel (80), p. 99, pl. xxxiiiA, figs. 2–4.

[2] Feistmantel (80), p. 104, pl. xxxiA, figs. 4, 5.

[3] Feistmantel (90), p. 123, pl. xiii, figs. 4, 4*a*; cf. figure of *G. Browniana*, ibid., pl. xvii, fig. 7.

[4] Feistmantel (90), p. 125, pl. xx, fig. 4.

[5] Feistmantel (90), p. 126, pl. xviii, figs. 2–4.

or Feistmantel's other species were obtained, and better figures of them reproduced, some of those included here with *G. Browniana* might be found to be distinct, but at present there does not appear to be any good evidence for separating them.

The plant named *G. reticulum* by Dana[1] is undoubtedly a frond of *Glossopteris Browniana*, with fairly broad meshes. Dana himself admitted the similarity between these two fronds, but was misled by the inaccuracy of Brongniart's figure. I believe the same author's[2] *G. elongata* to be merely a basal portion of a frond of *G. Browniana* (cf. Pl. II, Fig. 3) with open meshes, although at first sight his drawing seems to agree more closely with *G. retifera*.

Glossopteris Sutherlandi, Tate, appears to be simply one of the narrow, linear fronds here included under *G. Browniana*. The genus and species proposed by the same author,[3] *Rubidgea Mackayi*, was founded on a drawing of a specimen sent from South Africa, and now in the Museum of the Geological Society of London. In the sketch, the veins do not anastomose, and apparently there is no midrib. It is impossible to determine this plant accurately without seeing the actual specimen. Feistmantel[4] has compared it with the leaves of *Palæovittaria*, but for the present its identity is best regarded as uncertain. The two species from New South Wales, *G. rectinervis* and *G. acuta*, recently distinguished by Dun,[5] hardly appear to me to be distinct forms. The frond of *G. rectinervis* may be compared with some of the narrow, linear fronds, included here under *G. Browniana*, from which it differs chiefly in the very oblique nature of the lateral nervation. But in the specimens figured by this author this character does not seem to be at all constant, and further it is one which appears to me to be extremely unreliable. The specimen of *G. acuta* is too fragmentary to serve as the type of a new species, although the discovery of further examples of this, or possibly of the previous species, may show that these fronds are really distinct.

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[1] Dana (49), p. 717, pl. xiii, fig. 2.
[2] Dana (49), p. 718, pl. xiii, fig. 4.
[3] Tate (67), p. 141, pl. v, fig. 8.
[4] Feistmantel (89), p. 48.
[5] Dun (97), pp. 64–5, pl. ix, figs. 1–5. See also Etheridge (01), p. 71.

Distribution.—Permo-Carboniferous (Glossopteris flora):—India, in the Damuda division; New South Wales, in the "Lower Coal Measures," and Newcastle Series; Queensland, in the Bowen River Coalfield; Western Australia; Tasmania, in the Mersey River Coalfield, etc.; Cape Colony, Natal, Transvaal, Orange River Colony, Rhodesia (?), Portuguese East Africa. *Triassic:*—Tonquin.

Fronds of Glossopteris Browniana from New South Wales.

V. 7281. Pl. II, Figs. 1 and 3.

A slab of shale showing several well-preserved fronds, and illustrating the great variety in size and shape exhibited by the fronds belonging to this species. The fine frond figured on Pl. II, Fig. 1 measures 14 cm. in length, and 3·8 cm. across at its widest part. The midrib is distinct, and extends to the bluntly pointed apex. The lateral nervation is very clear. The meshes are rather narrower, and more elongate than in many examples of this species. The obliquity of the nerves varies greatly in different parts of the frond. The angle of divergence of the lateral nerves from the midrib is acute near the apex, and more oblique near the base. The nerves arch near their point of origin.

Several other, smaller, and narrower fronds occur on the same specimen, probably all belonging to the same species. Pl. II, Fig. 3 shows a basal portion of a frond, tapering gradually towards the point of attachment. The midrib is thick, the meshes are large and broad, and the lateral nervation is very oblique. This specimen recalls somewhat that figured by Dana as *G. elongata*, which is probably only a basal portion of a frond of *G. Browniana*. Other and narrower fronds, corresponding with McCoy's *G. linearis*, are found on the same specimen, and are here included under the *G. Browniana*.

Old Lambton, Newcastle.

41,175. Pl. II, Fig. 2. Figured by Morris (45), pl. vi, figs. 1, 1*a*.

The frond figured by Morris, which is not refigured here, is the nearly perfect of several fine fronds of *G. Browniana* shown on this specimen. It is a spathulate leaf, the meshes of which are rather narrower than in many other examples of this species. Among the fronds on the same specimen there occurs one (Pl. II, Fig. 2)

which is more linear in shape, and has an oblique lateral nervation. The midrib is strong and extends to the apex, and the meshes are fairly broad. It may be regarded as a narrow frond of the same species, and is not unlike McCoy's *G. linearis*. Several other linear fronds occur on the same specimen, some of which are only 7 mm. across.

Newcastle coal-mines. *Strzelecki Coll.*

V. 7207. Pl. III, Fig. 2.

The specimen figured is a median portion of a frond of fairly large size, with the broad meshes characteristic of *G. Browniana*. The specimen also shows several imperfections, consisting of holes irregularly arranged on either side of the midrib, similar to those on other fronds which have been described as indications of sori. It is almost certain, however, that these features have no connection with the fructification.

Port Stephens. *Odinheimer Coll.*

52,812. Pl. III, Fig. 1.

A complete frond, spathulate in shape, with broad meshes. The midrib does not quite extend to the apex. Numerous pustule-like bodies occur scattered over the surface of the frond, which have probably no connection with the fructification. Other and more imperfect fragments also occur on the same specimen.

Liverpool Range. *Presented by W. L. R. Gipps, Esq.*, 1875.

V. 7296. A piece of pink shale showing a number of fronds. One of these is an almost perfect leaf, widest towards the apex, and tapering gradually at the base. The meshes are somewhat narrower, and more elongate than in many examples of this species, but this character varies slightly among the fronds on the same slab. There is also another fragment, showing the obtuse apex, in which the midrib splits up into fine veins before reaching the apex, a feature which may be often noticed in the fronds of this species.

On the first-mentioned leaf, two hollows are seen containing three or more small bodies, which might at first glance be taken for the fructification, but which are probably of an entirely different nature. A triangular scale-frond, probably of *G. Browniana*, occurs on the same slab.

Port Stephens. *Odinheimer Coll.*

V. 7291. A well-preserved apical portion of a frond. The midrib hardly extends to the obtuse apex. The meshes are fairly broad and polygonal.

Port Stephens. *Odinheimer Coll.*

39,188. A slab showing several fronds which vary greatly in size and shape. The best example is a complete elongate-elliptical frond, 19·5 cm. in length and 6·5 cm. broad at its widest point. The nervation is not, however, very clear. Other and smaller fragments are more spathulate, some being apical, and others basal portions. In some of these the nervation is better preserved.

Newcastle. *Presented by Capt. Sir E. Home* (?), 1859.

V. 648. A large triangular slab containing hundreds of impressions of small fronds of *G. Browniana*, of an average length of 5 cm. and a greatest width of 13 mm. The nervation is, in most cases, not well preserved. This specimen affords excellent material for a study of the variations in shape and size which occur in fronds of this species. Most of these fronds are probably immature. An occasional scale-frond also occurs.

Old Lambton Colliery, near Newcastle. *Purchased*, 1884.

V. 7350. A slab showing several fronds varying greatly in shape, some being spathulate, others more oval. There is also considerable variation in the breadth of the meshes. The nervation is very clear. On the back of the specimen, there are some more imperfect fragments, and also a scale-frond.

Old Lambton, near Newcastle.

V. 2837. A slab of shale showing two well preserved fronds and the basal portion of another. The meshes are fairly broad, and the nervation clear. The rock, as in many other specimens, is largely composed of impressions of fronds of *Glossopteris*.

Nobby's, Newcastle.

Presented by the Australian Commissioners of the Indian and Colonial Exhibition, 1886.

V. 4283. A badly preserved frond, but an interesting specimen, showing the gradual tapering of the frond at the base towards the point of attachment. A specimen of the rhizome (*Vertebraria*) occurs near this frond.

Port Stephens. *Odinheimer Coll.*

V. 7293. A basal portion of a frond with a fairly thick midrib, and very acute nervation, the meshes being somewhat elongately polygonal. Fragments of a rhizome and of another frond also occur.

Port Stephens. *Odinheimer Coll.*

52,612. A piece of pinkish shale showing four fragments of typical fronds of this species, in which the nervation is clearly seen. A narrower leaf and a small convex scale-frond, the latter not very well preserved, are associated. *Morris Coll.*

V. 7721. Several fragments of fronds of various sizes, and a convex scale-frond, 1·6 cm. long, with an acuminate apex.

Port Stephens. *Odinheimer Coll.*

V. 7294. An apical portion of a fair-sized frond, with a midrib extending to the apex. The specimen is interesting on account of the very oblique lateral nervation, but the individual veins are not very distinct.

Port Stephens. *Odinheimer Coll.*

52,813. Several small fragments of fronds, one of which is of the narrow, linear type.

Liverpool Range. *Presented by W. L. R. Gipps, Esq.*, 1875.

V. 220 and **V. 220***a*. Fragments of fronds of fair size with rather narrow meshes.

Port Stephens. *Morris Coll.*

39,190. Small fragments of fronds with broad, elongate meshes, showing the nervation very clearly.

Newcastle Coalfield. *Presented by Sir E. Home*, 1859.

39,145 and **39,146.** Pieces of shale showing many fragments of medium-sized fronds, one of which is fairly perfect, and has rather narrow nets.

Port Stephens. *Pres. by N.S. Wales Geol. Surv. and Mus.*, 1859.

V. 6250. Among other fragments of fronds shown on this specimen, there is an apical portion with the typical nervation.

Port Stephens. *Odinheimer Coll.*

V. 7283. Several fragments of typical fronds of *G. Browniana*, some with fairly broad, and others with narrower meshes.

V. 10,389. A basal portion of a frond, showing the long tapering base. Nervation not very distinct.

Tallawang, Talbragar Coalfield.

V. 7203. Several comparatively small, spathulate fronds, the meshes of which are not very broad, occurring in association with a rhizome (*Vertebraria*).

Port Stephens. *Odinheimer Coll.*

V. 7279. A number of very imperfect fronds. Nervation not very clear.

Newcastle, Hunter River.

V. 7280. A piece of rock largely composed of fragments of fronds of *G Browniana*, some with fairly broad, others with rather narrower meshes.

Newcastle. *Gregory Coll.*

V. 7292. A complete frond of medium size, narrowly spathulate in shape, with indistinct nervation.

Port Stephens. *Odinheimer Coll.*

V. 7229. A complete frond showing the contracted basal portion. Nervation indistinct.

39,147. A piece of rock largely composed of spathulate or oval-linear fronds.

Port Stephens. *Pres. by N.S. Wales Geol. Surv. and Mus.*, 1859.

V. 7230. Fragments of fronds with fairly broad, polygonal meshes.

Port Stephens. *Odinheimer Coll.*

V. 7295. Portions of somewhat narrow, linear fronds, whose nervation is not very clear.

Port Stephens. *Odinheimer Coll.*

V. 7205. Fragments of oval-linear fronds, one of which shows the apex. The nervation is not very distinct.

Port Stephens. *Odinheimer Coll.*

V. 9365 and **V. 9368.** A specimen and its counterpart, showing a spathulate frond with indistinct nervation, as well as other fragments.

Cullen Bullen, near Lithgow. *Pres. by H. F. Collins, Esq.*, 1903.

V. 4295. Fragments of fronds with fairly broad, elongate meshes, occurring with a seed-like fossil and a rhizome.

39,150. An oval-linear frond, somewhat acuminate at the apex, and with narrow meshes. Also a basal portion of a frond showing larger meshes.

Port Stephens. *Pres. by N.S. Wales Geol. Surv. and Mus.*, 1859.

V. 7231. A nearly perfect frond, apparently of the narrow-leaved type of *G. Browniana*, rather more than 9 cm. long and 2 cm. broad. The nervation is very acute.

Port Stephens. *Odinheimer Coll.*

V. 10,648. A number of fragments of fair-sized fronds, some showing the nervation clearly.

Newcastle. *Keene Coll.*

V. 10,649. Two specimens with fragments of fronds of a narrower or more linear type. The nervation is seen here and there.

Tomago Colliery (at a depth of 342 feet), Hunter River. *Keene Coll.*

Other specimens: — **53,562** and **53,564** (Australia), **32,447** (three specimens from the Hunter River, near Coal-mines; *pres. by Sir E. Home*, 1853), **39,148** (Port Stephens; *pres. by N.S. Wales Geol. Surv. and Mus.*, 1859), **39,189** and **39,191** (Newcastle Coalfield; *pres. by Sir E. Home*, 1859), **40,942** (three specimens from the Newcastle Coalfield; *pres. by Sir E. Home*, 1860), **V. 2109** (Australia; *pres. by Sir C. Purdon Clarke*, 1889), **V. 2753** (Cullen Bullen; *pres. by W. H. Shrubsole, Esq.*, 1892), **V. 4282** (Australia; *pres. by W. H. Shrubsole, Esq.*, 1892), **V. 6250***a*, **V. 6250***b*, and **V. 7204** (Port Stephens; *Odinheimer Coll.*), **V. 7282** (? N.S. Wales), **V. 7292** (Port Stephens; *Odinheimer Coll.*), **V. 9366** and **V. 9367** (Cullen Bullen; *pres. by H. F. Collins, Esq.*, 1903), **V. 10,646** and **V. 10,647** (Tomago Colliery, Hunter River; *Keene Coll.*).

Fronds of Glossopteris Browniana from Queensland.

V. 4200. A small fragment with a very oblique network almost at right angles to the midrib.

Bowen River.

V. 4201*c*. A small portion of a frond with the typical nervation of this species.

V. 4201*a*. A median portion of a frond. The midrib is very thick, but the lateral nervation is not very clear.

V. 4201*b*. A fragment similar to the above, 12 cm. long, with a very broad midrib, and fairly acute lateral nervation.

Other specimens:—**V. 4201** (several fragments), **V. 5952, V. 5953.**

NOTE.—The specimens registered as **V. 4200-1** are possibly those described by Carruthers in 1880—see Carruthers (72) and (80)—but there is no record to this effect.

Fronds of Glossopteris Browniana from Tasmania.

V. 3776*c*. A good specimen of an apical portion of a frond probably of this species. The midrib does not extend to the apex. Also several fragments, some probably belonging to other species, in association with *Noeggerathiopsis*.

Mersey River. *Pres. by T. Stephens, Esq.*, 1898.

V. 3776*d*. Among other fragments, a narrow frond with obscure midrib, probably belonging to *G. Browniana*.

Mersey River. *Pres. by T. Stephens, Esq.*, 1898.

V. 3776*g*, V. 3776*h*, V. 3776*i*. Small fragments of fronds of this species, some showing the nervation clearly.

Mersey River. *Pres. by T. Stephens, Esq.*, 1898.

Fronds of G. Browniana from the Cape Colony.

V. 3256. A small fragment of a narrow frond, with well-marked nervation.

Fair View Mine. *Pres. by D. D. Fraser, Esq.*, 1893.

V. 3257. A large, rather broad frond, but badly preserved, with indistinct nervation. This determination is doubtful.

Bedford. *Pres. by D. D. Fraser, Esq.*, 1893.

V. 2482, V. 2482*a*. A piece of white shale and its counterpart, containing some badly preserved fragments probably of this species, but the nervation is indistinct.

Kimberley Mine. *Pres. by G. J. Lee, Esq.*, 1890.

Glossopteris, sp., from Cape Colony.

V. 3258 (Bedford), **V. 3269** (Bootha's Drift, Great Fish River), **V. 3259** (Bedford), *all presented by D. D. Fraser, Esq.*, 1893. Also **V. 2415** (two specimens from ? Vice's Pit, Stormberg), **V. 7351** (? loc.).

Fronds of Glossopteris Browniana from Natal.

V. 3132, V. 3132*a*, V. 7583. A specimen and its counterpart showing numerous fronds of *G. Browniana*, *G. indica*, and others probably identical with *G. angustifolia*. Some of these are well preserved, and the nervation is very clear. The fronds of *G. Browniana* show considerable variation in the nervation. A fragment of a *Sphenophyllum* (see p. 36, Text fig. 11) also occurs on this specimen. *Pres. by the Natal Government*, 1897.

V. 7353. Fragments of fronds of *G. Browniana*, showing the nervation clearly.

Estcourt.

V. 4284. A similar specimen with fronds of various sizes belonging to both *G. Browniana* and *G. indica*, some of which show the nervation clearly.

Estcourt.

52,856. Several fragments of fronds of this species.

Estcourt.

V. 2904. A narrow linear frond 8·2 cm. long, and 1·5 cm. across. The midrib is well-marked, and the meshes are fairly broad. Some fragments of *G. retifera* are also associated.

Farm Glencalder (at 6,700 feet s.m.), Newcastle division.

Pres. by D. Draper, Esq., 1893.

V. 2905*a*, **V. 2905***b*, **V. 2905***c*, **V. 2905***d*, **V. 2905***e*. Imperfect fragments of fronds, some of which are basal portions with very oblique nervation. Root-like remains also occur in some cases.

Farm Glencalder (at 6,700 feet s m.), Newcastle division.

Pres. by D. Draper, Esq., 1893.

V. 2905*f*. A narrow linear-lanceolate frond, nearly complete. Nervation not very clear, but probably that of this species.

Farm Glencalder. *Pres. by D. Draper, Esq.*, 1893.

V. 2904*a*. A mass of fronds chiefly belonging to this species.

Farm Glencalder. *Pres. by D. Draper, Esq.*, 1893.

V. 2907, V. 2908. Small fragments of rather narrow fronds of *G. Browniana.*

Farm Glencalder. *Pres. by D. Draper, Esq.*, 1893.

V. 7348, V. 7352. Pieces of black shale showing several fragments of fronds, some of them narrow and linear in shape, all being probably referable to this species. *Sutherland Coll.*

Glossopteris, sp., from Natal.

V. 2905 (several specimens), **V. 2906.** (Farm Glencalder, Newcastle division ; *pres. by D. Draper, Esq.*, 1893.)

Fronds of Glossopteris Browniana from the Transvaal and Orange River Colony.

V. 3610. Figured by Seward (97[1]), pl. xxi, fig. 1.

An apical portion of a frond about 5 cm. long. The meshes

are rather narrow, but the leaf probably belongs to this species. A number of elliptical or circular holes occur in the lamina on either side of the midrib, which are probably due to tearing of the frond, and have no connection with the fructification.

Boschmans Fontein, Middelburg.

Pres. by D. Draper, Esq., 1897.

V. 3618. Figured by Seward (97[1]), pl. xxii, fig. 4, and text-fig. 1*b* on p. 324.

A small fragment of a frond occurring with a Lepidodendroid impression.

Vereeniging. *Pres. by D. Draper, Esq.*, 1897.

V. 2465. Fronds of *G. Browniana* occur on this specimen in association with *G. conspicua* and *G. retifera.*

Mill River Drift, Harrismith. *Pres. by D. Draper, Esq.*, 1890.

Glossopteris, sp., from the Transvaal and Orange River Colony.

Fronds with the nervation imperfectly preserved:—**V. 8319** and **V. 8320** (Vereeniging; *pres. by Dr. F. H. Hatch*, 1898), **V. 3624** (Vereeniging; *pres. by D. Draper, Esq.*, 1897), **V. 2902** (several specimens from Mill River Ford, Harrismith; *pres. by D. Draper, Esq.*, 1893).

Glossopteris, sp., from Rhodesia.

V. 7592. This specimen shows two fair-sized fragments of lanceolate or oval leaves. The lateral nervation is unfortunately not preserved, but the form of the leaf suggests a comparison with *G. Browniana* or *G. indica.* In describing this specimen in 1903,[1] I pointed out that parallel rows of small oval or circular protuberances, minute knobs, or dot-like pits, occur along the midrib and the lamina bordering on the midrib. I suggested provisionally that these might have some connection with the fructification. A more extended examination of these specimens has not supported this view, but I am still unable to account for the features presented by these fronds.

Sisi siding, Bechuanaland Railway.

Pres. by A. J. C. Molyneux, Esq., 1901.

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[1] Arber (03), p. 288.

V. 7593. In addition to a broad leaf, which I regard as possibly identical with *G. ampla*, there occur on this specimen fragments of narrower fronds which show features similar to those exhibited by the preceding specimen.

Sisi siding. *Pres. by A. J. C. Molyneux, Esq.*, 1901.

Fronds of Glossopteris Browniana from South America.

V. 7152. A faint impression of a rather broad frond, with a very oblique lateral nervation. The secondary nerves are very indistinct, but the leaf probably belongs to this species.

Argentina. *Pres. by H. D. Hoskold, Esq.*, 1890.

V. 7151. A frond similar to **V. 7152**, but slightly broader and the lateral nervation better preserved in places. The secondary nerves are again very oblique, and the meshes fairly broad.

Argentina. *Pres. by H. D. Hoskold, Esq.*, 1890.

Scale-fronds of Glossopteris Browniana from New South Wales.

V. 7202, V. 7211, 39,149, described and figured on pp. 40–45; **52,612,** see p. 58; **V. 648,** see p. 57; **V. 7296,** see p. 56; **V. 7350,** see p. 57; **V. 7721,** see p. 58.

2. Glossopteris indica, Schimper.

(Text-figs. 17 and 18*a*.)

1828. *Glossopteris Browniana* (pars), Brongniart, Prodr. Hist. Végét. foss., p. 54.

1830. *G. Browniana*, var. *indica*, Brongniart, Hist. Végét. foss., p. 223, pl. lxii (pars).

1861. *G. Browniana*, var. *indica*, Bunbury, Quart. Journ. Geol. Soc., vol. xvii, p. 326, pl. viii, figs. 1–4.

1869. *G. indica*, Schimper, Traité, vol. i, p. 645.

1876. *G. communis*, Feistmantel, Journ. Asiat. Soc. Bengal, vol. xlv, pt. 2, p. 375, pl. xxi, fig. 5.

1877. *G. stenoneura*, Feistmantel, Rec. Geol. Surv. India, vol. x, pt. 2, p. 74.

1878. *G. tæniopteroides*, Feistmantel, Palæontogr., Suppl. iii, p. 92, pl. ix, figs. 1, 1*a*.

? *G. primæva*, Feistmantel, ibid., p. 79, pl. v, figs. 3, 3*a*.

1879. *G. communis*, Feistmantel, Flora Gondw. Syst., vol. iii, pt. 1, p. 16, pl. xvii, figs. 1, 2; and Suppl. (1881), p. 53, pl. xxxi, figs. 4, 5.

1880. *G. indica*, Feistmantel, Flora Gondw. Syst., vol. iii, pts. 2, 3, p. 101, pl. xxiv A (pars); pl. xxv A, figs. 1–3; pl. xxvi A, fig. 3; pl. xxvii A, figs. 3–5; pl. xxxv A, fig. 4; pl. xxxviii A, fig. 4.

Glossopteris communis, Feistmantel, ibid., p. 98, pl. xxiv A (pars); pl. xxvi A, figs. 1, 4; pl. xxvii A, fig. 1; pl. xxix A, figs. 4, 5, 9; pl. xxxii A, fig. 2; pl. xxxv A, figs. 1–3; pl. xxxvi A, figs. 1, 2; pl. xxxvii A, figs. 3, 4; pl. xxxviii A, figs. 1, 2; ? pl. xl A, fig. 4.

G. communis, var. *stenoneura*, Feistmantel, ibid., p. 99, pl. xxxii A, fig. 3; pl. xxxiii A, fig. 1; pl. xxxviii A, fig. 5.

1882. *G. indica*, Feistmantel, ibid., vol. iv, pt. 1, p. 33.

G. communis, Feistmantel, ibid., p. 32, pl. xii, figs. 1, 1*a*; pl. xxi, figs. 13, 14.

1883. *G. tæniopteroides*, Tenison-Woods, Proc. Linn. Soc. New South Wales, vol. viii, p. 125.

? *G. primæva*, Tenison-Woods, ibid., p. 126.

1886. *G. indica*, Feistmantel, Flora Gondw. Syst., vol. iv, pt. 2, p. 27, pl. xii A, figs. 2, 6*b*; pl. xiv A, fig. 7.

G. communis, Feistmantel, ibid., p. 26, pl. ii A, figs. 1, 2; pl. xi A, figs. 6, 8; pl. xii A, figs. 1, 5*a*, 5*b*, 6*a*.

G. communis, var. *stenoneura*, Feistmantel, ibid., p. 27.

G. tæniopteroides, Johnston, Papers and Proc. R. Soc. Tasmania for 1885, p. 378.

1889. *G. communis*, Feistmantel, Abhand. böhm. Gesell. Wiss. Prag, ser. VII, vol. iii, p. 45.

1890. *G. communis*, Feistmantel, Mem. Geol. Surv. New South Wales, Pal., No. 3, p. 123, pl. xvii, figs. 2, 6.

G. tæniopteroides, Feistmantel, ibid., p. 128, pl. xviii, figs. 1, 1*a*.

? *G. primæva*, Feistmantel, ibid., p. 127, pl. xiii, figs. 3, 3*a*.

1893. *G. communis*, Oldham, Man. Geol. India, 2nd pl. opp. p. 162.

1896. *G. indica*, Zeiller, Bull. Soc. Géol France, ser. III, vol. xxiv, p. 366, text-figs. 11, 12; pl. xvii, figs. 1–3.

G. communis, Bodenbender, Zeitschr. deutsch. geol. Gesell., vol. xlviii, table opposite p. 772.

1897. *G. communis*, Oldham, Rec. Geol. Surv. India, vol. xxx, pt. 1, p. 45, pl. iii (pars).

1900. *G. indica*, Potonié, in Deutsch. Ost-Afrika, vol. vii, p. 496, fig. 22.

1901. *G. Browniana*, var. *indica*, Etheridge, jun., in Anderson, 1st Rep. Geol. Surv. Natal, p. 69.

1902. *G. indica*, Zeiller, Pal. Indica, N.S., vol. ii, p. 8, pl. i, figs. 1–5; pl. ii, figs. 1–4; pl. iii, figs. 1, 3.

G. indica, Zeiller, Flore Foss. Gîtes Charb. Tonkin, p. 84, and p. 296, pl. xvi, figs. 2–5; pl. lvi, fig. 1.

G. communis, Shirley, Bull. 18, Geol. Surv. Queensland, p. 13.

1903. *G. Browniana*, var. *indica*, Seward, Ann. S. African Mus., vol. iv, pt. 1, pp. 78, 80, pl. x, figs. 3, 4; pl. xiii, fig. 1.

1904. *G. Browniana*, var. *indica*, Seward, in 2nd Rep. Geol. Surv. Natal, p. 99, pl. iv, fig. 2.

Scale-fronds of Glossopteris indica, Schimper.

1902. *Glossopteris indica*, Zeiller, Pal. Indica, N.S., vol. ii, p. 12, pl. iii, figs. 4–13.

Type. No. 506, Muséum d'histoire naturelle, Paris.

Fronds often large, but varying greatly in size, shape, and in the details of the nervation. Fronds elongate-lanceolate, or broadly oval-lanceolate, gradually contracted at the base. Apex acute, or acuminate. Midrib stout, persisting to the apex.

Secondary nerves numerous, crowded, arched near the midrib, sub-parallel, straight, meshes narrow, very elongate, polygonal, rhomboidal, or trapezoidal. Meshes larger on the borders of the midrib, contracting towards the margin.

Scale-fronds more or less rhomboidal with lateral angles rounded; 15–50 mm. in length and 15–25 mm. broad. No median nerve; lateral nervation arched, forming elongate meshes.

The chief characters which distinguish *G. indica* from other species are the large, lanceolate, acute fronds, with their close,

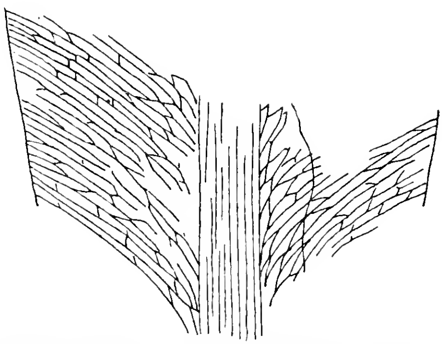

FIG. 17.—*Glossopteris indica*, Schimper. Enlarged drawing of the nervation of the type-specimen. After Zeiller. × 1½.

sub-parallel secondary nervation, and transversely elongate areoles. The fronds measure 15–40 cm. in length, and are 2·5 – 10 cm. broad at widest part.

Zeiller[1] has recently given a detailed account of the variations in the habit and nervation of this species. Sometimes the meshes are larger near the midrib than at the margin, and in other specimens they are more nearly equal in size. The course of the nerves is also somewhat less parallel and less regular in some

[1] Zeiller (96[1]), p. 366; (02[1]), p. 8.

specimens than in others. Zeiller[1] has also added an interesting figure of the epidermis and stomata of this type of frond as seen in surface view.

Brongniart's[2] original figure of this plant is inaccurately drawn, as Bunbury and others have pointed out. The secondary nerves in this species anastomose throughout the lamina, and are not, as shown by Brongniart, free for the greater part of their course. Exact drawings of the nervation of the type-specimen have been published recently by Zeiller[3] (Text-fig. 17).

This type of frond was described originally by Brongniart[2] in 1828 as a variety of *Glossopteris Browniana*, but in 1869 Schimper[4] raised it to specific rank, and this conclusion is maintained here.

In 1876 Feistmantel[5] distinguished from *G. indica* certain fronds of somewhat similar form under the name of *G. communis*, Feist., which were stated to be larger and broader in habit, with longer and narrower meshes close to the midrib. Zeiller[6] has, however, shown in detail that none of these characters are constant, and that it is impossible to separate these two fronds. With this conclusion I entirely agree. It may be also mentioned that Zeiller[7] has instituted a most careful comparison between *G. Browniana* and *G. indica*, bringing out clearly the essential differences between these two species.

Feistmantel[8] has distinguished some small leaves of this type as *G. communis*, var. *stenoneura*, but in view of the great variation in the size of these fronds it seems hardly necessary to adopt this name.

Zeiller[9] has remarked that Feistmantel's[10] species *G. tæniopteroides*, a large leaf from New South Wales with a very oblique and close secondary nervation, is probably a frond of *G. indica*, and I am of the same opinion. As he suggests, it is exceedingly like some of the Indian fronds (cf. Zeiller (02^1), pl. iii, figs. 3, 3*a*) which he has recently figured.

The single specimen from the Lower Coal-measures at Greta,

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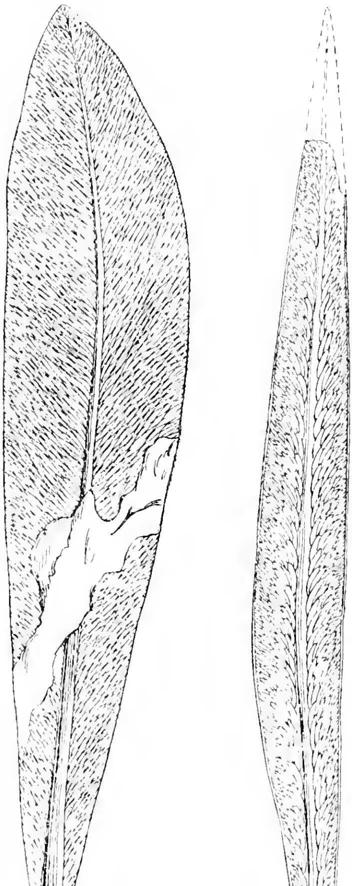
[1] Zeiller (96^1), p. 368, fig. 13.
[2] Brongniart (28^2), p. 223, pl. lxii (pars).
[3] Zeiller (96^1), p. 367, figs. 11, 12.
[4] Schimper (69), vol. i, p. 645.
[5] Feistmantel (76^2), p. 375.
[6] Zeiller (96^1), p. 368; (02^1), p. 8.
[7] Zeiller (02^1), p. 12.
[8] Feistmantel (80), p. 99.
[9] Zeiller (02^1), p. 11.
[10] Feistmantel (90), p. 128, pl. xviii, figs. 1, 1*a*.

New South Wales, on which Feistmantel[1] founded his species *G. primæva*, is too imperfect and fragmentary to be considered



A B

FIG. 18.—(A) *Glossopteris indica*, Schimper. Reduced drawing of a frond. $\frac{1}{2}$ nat. size. (B) *Glossopteris angustifolia*, Brongniart. Nat. size. Both after Feistmantel.

[1] Feistmantel (90), p. 127, pl. xiii, figs. 3, 3*a*.

satisfactory. It recalls the basal portions of some fronds of the type of *G. indica*, a species known to occur in New South Wales.

The fronds named by Bunbury[1] *Filicites*, sp., and *Filicites* (qu. *Glossopteris*, sp.?) are, no doubt, badly preserved fronds of a *Glossopteris*, which in the latter case are probably still attached to the rhizome.

Distribution.—Permo-Carboniferous (Glossopteris flora):—India, in the Talchir and Damuda divisions; New South Wales, in the Newcastle Series; Queensland, Tasmania, Cape Colony, Transvaal, Portuguese East Africa, Argentina. *Permian* (Northern Type):—Russia. *Triassic*:—India (in the Panchet division), Tonquin, China.

Fronds of Glossopteris indica from India.

V. 7144. A frond showing the midrib and the nervation, in association with a fragmentary frond of larger size, with broader meshes, and a very oblique nervation. The latter frond is not sufficiently well-preserved to permit of specific identification.

Nágpur. *Hunter Coll.*

V. 7129. Fragments of two fronds, rather imperfect, but showing the nervation fairly well in places. The larger frond shows the lanceolate form of the leaf, while in the smaller the details of the nervation may be observed.

Silewáda, 12 miles north of Nágpur. *Hunter Coll.*

V. 7142. Three fragmentary fronds, the broadest being 5·4 cm. across. This is probably a median portion of a leaf, and shows clearly the stout midrib, and the sub-parallel course of the lateral nerves forming very elongate meshes. The other fragments are similar.

Near Nágpur. *Hunter Coll.*

V. 7146. Several incomplete fronds of this species in association with leaves of *G. stricta*. Three basal portions of *G. indica* are seen, which show the midrib and nervation.

Near Nágpur. *Hunter Coll.*

V. 7101*c*. Several fronds showing the shape of the leaf, but the lateral nervation is badly preserved. Other and narrower fronds, probably belonging to *G. angustifolia*, are associated.

Bardwán Coalfield.

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[1] Bunbury (61), p. 333, pl. x, figs. 3, 4.

V. 7232. A large slab of shale containing impressions of several fronds of *G. indica*, and also of *G. angustifolia*. The lateral nervation is not very clear.

V. 7185. A small portion of a frond, probably an apical portion, showing the sub-parallel nerves and elongate meshes.

Near Nágpur. *Sankey Coll.*

V. 7184. A piece of dark-coloured shale showing two fronds, one of which is rather narrow, with an acute lateral nervation. The other is an apical portion of a frond, in which the nervation is indistinct.

Near Nágpur. *Sankey Coll.*

V. 7125. A basal portion of a frond, showing parallel rows of minute protuberances along the midrib, similar to those occurring on the *Glossopteris* from Rhodesia (V. 7592), described on p. 63.

Denwa, near Bhuwan. *Hunter Coll.*

V. 7188. Fragments of fronds showing the nervation. Also a basal portion of a frond with rows of small pustules along the midrib.

Nágpur. *Sankey Coll.*

V. 7122. Several basal portions of fronds showing minute pustules along the midrib.

Near Bhuwan, 120 miles N.N.W. of Nágpur. *Hunter Coll.*

V. 7119. A long basal portion of a leaf, probably of this species, with rows of small pustules along the centre of the frond.

Near Bhuwan, 120 miles N.N.W. of Nágpur. *Hunter Coll.*

V. 7123. A small portion of the upper part of a frond showing the nervation somewhat indistinctly.

Near Bhuwan, 120 miles N.N.W. of Nágpur. *Hunter Coll.*

V. 7124. Basal and apical portions of fronds probably of this species.

Near Bhuwan, 120 miles N.N.W. of Nágpur. *Hunter Coll.*

V. 7118. Fragments of fronds of this species and others in which the nervation is not clear, but which show rows of minute pustules along the centre of the leaf.

Near Bhuwan, 120 miles N.N.W. of Nágpur. *Hunter Coll.*

Glossopteris, sp., from India.

V. 7101*d*, **V. 7101***f* (Bardwán Coalfield).

V. 7120, V. 7121, V. 7122, V. 7126, V. 7127 (all from near Bhuwan, 120 miles N.N.W. of Nágpur on north bank of the Denwa, *Hunter Coll.*); **V. 7128** (*Hunter Coll.*); ? **V. 7187** (a doubtful fossil from near Nágpur, *Sankey Coll.*).

Fronds of Glossopteris indica from the Transvaal.

V. 3612. Figured by Seward (97[1]), p. 321, pl. xxi, fig. 3.

The largest fragment is a rather indistinct impression of a frond, about 14 cm. long and 5·5 cm. broad, with a well-marked midrib. The lateral nervation is sufficiently well-preserved in places to enable one to refer it to this species. Other smaller fragments of fronds occur on the same specimen.

Vereeniging, Transvaal. *Pres. by D. Draper, Esq.*, 1897.

V. 3611. Figured by Seward (97[1]), p. 320, pl. xxi, fig. 2.

A small fragment of a median portion of a frond in which the midrib is hardly distinguishable.

Casey's Township, near Johannesburg.

Pres. by D. Draper, Esq., 1897.

V. 3610. Figured by Seward (97[1]), p. 320, pl. xxi, fig. 1.

A terminal portion of a frond, not very well preserved, but probably belonging to *G. indica*. The nervation is rather like that of the frond figured by Feistmantel as *G. communis*, var. *stenoneura* (Feistmantel (80), pl. xxxii A, fig. 3; pl. xxiii A, fig. 1).

Boschmans Fontein, Middelburg, Transvaal.

Pres. by D. Draper, Esq., 1897.

Fronds of Glossopteris indica from Tasmania.

V. 3776*e*. Two narrowly oval fronds probably belonging to this species. The lateral nervation is strongly arched, and the nerves nearly parallel. Other and similar fragments also occur.

Mersey River. *Pres. by T. Stephens, Esq.*, 1898.

V. 3776*f*. A portion of a frond, about 11 cm. in length and 4·5 cm. across. The preservation is fairly good.

Mersey River. *Pres. by T. Stephens, Esq.*, 1898.

V. 3776*a*. A slab of shale, largely composed of fragments of *Glossopteris*, *Noeggerathiopsis*, and other leaves. A large leaf of *G. indica*, 14 cm. long and 6 cm. across, is especially noticeable. The parallel anastomosing veins composing the midrib are well seen. Fragments of *G. ampla* are also associated.

Mersey River. *Pres. by T. Stephens, Esq.*, 1898.

Fronds of Glossopteris indica from Natal.

V. 3132, V. 3132*a*, V. 7583. A slab of shale and its counterpart, showing some fronds of this species with well-preserved nervation, associated with fronds of *G. Browniana*.

Pres. by the Natal Government, 1897.

V. 4284. This specimen shows several fronds, some of which appear to belong to this species.

Estcourt.

52,856. An almost perfect frond, with a strong midrib; and close, parallel lateral nervation. A broader, apical portion of another frond, and a basal portion of a third frond also occur.

Little Bushmans River, Estcourt.

Pres. by the Rev. G. Smith, 1876.

Scale-frond of Glossopteris indica (?).

V. 7186. A small, triangular, acuminate scale-frond, probably belonging to this species. The nervation is indistinct, and the leaf strongly concave.

Near Nágpur, India. *Sankey Coll.*

3. Glossopteris angustifolia, Brongniart.

(Text-figs. 18B and 19.)

1830–2. *Glossopteris angustifolia*, Brongniart, Hist. Végét. foss., p. 224, pl. lxiii, fig. 1.

1836. *G. angustifolia*, Göppert, Die Foss. Farn., p. 348.

1850. *G. angustifolia*, Unger, Gen. et Spec. Plant. foss., p. 169.

1861. *G. leptoneura*, Bunbury, Quart. Journ. Geol. Soc., vol. xvii, p. 330, pl. ix, figs. 1–4.

1876. *G. angustifolia*, Feistmantel, Rec. Geol. Surv. India, vol. ix, pt. 3, p. 72.

G. angustifolia, Feistmantel, Journ. Asiat. Soc. Bengal, vol. xlv, pt. 2, p. 374, pl. xxi, figs. 2–4.

1880. *Glossopteris angustifolia*, Feistmantel, Flora Gondw. Syst., vol. iii, pts. 2, 3, p. 105, pl. xxviiA, figs. 6, 8, 9, 11–13; pl. xxxivA, fig. 3; pl. xxxixA, figs. 1, 2.
G. leptoneura, Feistmantel, ibid., p. 106.
Sagenopteris longifolia, Feistmantel, ibid., p. 113, pl. xlA, fig. 1.
1882. *Glossopteris angustifolia*, Feistmantel, Flora Gondw. Syst., vol. iv, pt. 1, p. 35.
? *G. tænioides*, Feistmantel, ibid., p. 36, pl. xxi, figs. 4, 9.
1886. *G. angustifolia*, Feistmantel, ibid., vol. iv, pt. 2, p. 25, pl. v A, fig. 5.
1888. *G. angustifolia*, Johnston, Geol. Tasmania, p. 111.
1889. *G. angustifolia*, Feistmantel, Abhand. böhm. Gesell. Wiss. Prag, ser. VII, vol. iii, p. 43, pl. iv, fig. 5.
1893. *G. angustifolia*, Oldham, Man. Geol. India, 2nd pl. opp. p. 162.
1896. *G. angustifolia*, Zeiller, Bull. Soc. Géol. France, ser. III, vol. xxiv, p. 369, text-figs. 14, 15; pl. xviii, figs. 1–3.
1897. *G. Browniana*, var. *angustifolia*, Seward, Quart. Journ. Geol. Soc., vol. liii, p. 321, pl. xxi, fig. 4*a*.
1900. *G. angustifolia*, Potonié, in Deutsch. Ost-Afrika, vol. vii, p. 496.
1901. *G. Browniana*, var. *angustifolia*, Etheridge, jun., in Anderson, 1st Rep. Geol. Surv. Natal, p. 70.
1902. *G. angustifolia*, Zeiller, Pal. Indica, N.S., vol. ii, p. 16, pl. iv, figs. 3–5.
G. angustifolia, Zeiller, Flore Foss. Gîtes Charb. Tonkin, p. 297, pl. lvi, fig. 2.
1903. *G. Browniana*, var. *angustifolia*, Seward, Ann. S. African Mus., vol. iv, pt. 1, p. 81, pl. x, fig. 3.
1904. *G. Browniana*, var. *angustifolia*, Seward, 2nd Rep. Geol. Surv. Natal, p. 99, pl. iv, figs. 3, 4.

Type. No. 509, Muséum d'histoire naturelle, Paris.

Frond elongate, narrow, linear. Apex acute, or obtusely pointed; gradually contracted at the base. Midrib well-marked, persisting almost to the apex. Secondary nerves oblique, more or less arched near midrib, then becoming straight, crowded, forming rather narrow, elongate, polygonal meshes.

The chief characters of this species are the narrow, elongate fronds, with acute apices, and narrow, elongate meshes. The size of the frond varies considerably, from 5–15 cm. in length and 10–20 mm. in breadth.

There has been some doubt as to whether this form of frond is worthy of being regarded as a distinct species. Professor Zeiller[1] has upheld the specific rank, while Mr. Seward[2] has described it

[1] Zeiller (96[1]), p. 369; (02[1]), p. 16.
[2] Seward (97[1]), p. 317.

as a variety of *G. Browniana*. I am inclined to regard it as probable that *G. angustifolia* may have been borne on the same plant as *G. indica*, that it is simply a narrow frond corresponding with *G. indica* in much the same way as some of the narrower fronds of *G. Browniana* (e.g. that described by McCoy as *G. linearis*) were probably associated in the living state with the spathulate fronds usually regarded as typical of *G. Browniana*. It is a form practically unknown from Australia, where *G. indica* is rare, whereas it is fairly abundant in India and South Africa, where *G. indica* is of common occurrence. There is also a great similarity between the nervation of these two species, allowing for the difference in size and shape. On the other hand, *G. angustifolia* appears to be a fairly constant type of frond, whereas the narrower fronds here included under *G. Browniana* vary so greatly among

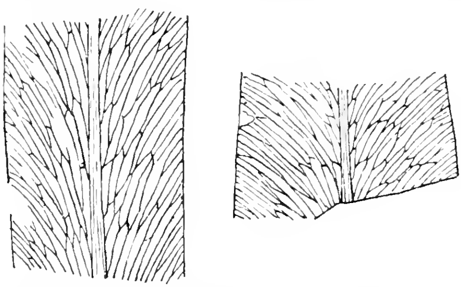

Fig. 19.—*Glossopteris angustifolia*, Brongniart. Enlarged drawings of the type-specimen. After Zeiller. × 2.

themselves that it seems hopeless to attempt to distinguish between them and the spathulate type. For this reason, and in view of the admittedly artificial nature of this classification (see p. 46), it seems convenient to maintain for the present the specific rank of *G. angustifolia*.

This species was first described by Brongniart,[1] who regarded it as distinct from *G. Browniana* and *G. indica*. The nervation of the type-specimens has recently been accurately refigured by Zeiller[2] (Text-fig. 19). As Feistmantel and Zeiller have pointed

[1] Brongniart (28^2), p. 224, pl. lxiii, fig. 1.
[2] Zeiller (96^1), p. 370, text-figs. 14, 15.

out, Brongniart's original figure is incorrect; the lateral nerves forming anastomoses quite to the margin, although individual nerves may here and there remain free from one another for a short distance.

The very long and narrow leaves from India, figured by Bunbury[1] as *G. leptoneura*, would seem to be hardly distinguishable except in size and shape from *G. angustifolia*. The lateral nerves are very oblique and fine, the meshes being somewhat more polygonal than in that species. This form is known only from the Nágpur district in India, and might conceivably be regarded as a variety of *G. angustifolia*. Characters depending on size and shape, especially in dealing with fronds of such varied habit as those of *Glossopteris*, seem to me to be extremely untrustworthy, and for the present it appears to be better to include the Nágpur leaf with *G. angustifolia*. Bunbury's type-specimens (Nos. R. 10,360–2) are preserved in the Museum of the Geological Society of London.

Some very imperfect fragments, somewhat recalling Bunbury's plant, were figured by Feistmantel[2] as *G. tænioides*, a type of narrow linear leaf with a strong midrib, but with few meshes in the network. This species may probably be also best included under *G. angustifolia*; at any rate, the evidence is too imperfect to warrant a new specific name.

Feistmantel[3] has figured a number of fronds radiating from a stem-like structure under the name *Sagenopteris longifolia*. I have no hesitation in regarding these as fronds of *G. angustifolia* attached to a rhizome. Zeiller has already expressed the same opinion. The specimen also figured by Feistmantel as *Sagenopteris* cf. *rhoifolia*[4] is possibly a scale-frond or a small frond of *Glossopteris*.

Distribution.—Permo-Carboniferous (Glossopteris flora):—India (Damuda division), Cape Colony, Natal, Transvaal, Portuguese East Africa. *Permian* (Northern Type):—Russia. *Triassic*:—Tonquin.

Fronds of Glossopteris angustifolia from India.

V. 7189. A fair-sized slab of shale, bearing impressions of

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1 Bunbury (61), p. 330, pl. ix, figs. 1–4.
2 Feistmantel (82^1), p. 36, pl. xxi, figs. 4, 9.
3 Feistmantel (80), p. 113, pl. xlA, fig. 1.
4 Feistmantel (80), p. 114, pl. xliiA, fig. 2.

several long, narrow fronds, one of which is 11 cm. long and about 2 cm. broad. The nervation and shape of the frond appear to be that of this species. *Sankey Coll*

V. 7101 and **V. 7101*a*.** Several badly-preserved fragments of fronds, some of which are long and linear, and probably belong to this species. The nervation is not well preserved.

Bardwán Coalfield.

V. 7101*b*. Fragments of narrow leaves, in which the nervation can be seen here and there. Some of the fronds show the shape of the leaf fairly well.

Bardwán Coalfield.

Other specimens:—**V. 7101*e***, **V. 7101*g***, **V. 7101*h*** (Bardwán Coalfield, India).

Fronds of Glossopteris angustifolia from South Africa.

V. 3613. Figured by Seward (97[1]), p. 321, pl. xxi, fig. 4*a*.

An imperfect fragment of a linear frond, about 11·5 cm. long, in association with *Noeggerathiopsis Hislopi*.

Casey's Township, Transvaal. *Pres. by D. Draper, Esq.*, 1897.

V. 3132*a*. Among a number of scattered fronds shown on this specimen are some probably belonging to this species, associated with *G. Browniana* and *G. indica*.

Natal. *Pres. by the Natal Government*, 1894.

4. Glossopteris stricta, Bunbury.

(Pl. IV, Fig. 1.)

1861. *Glossopteris stricta*, Bunbury, Quart. Journ. Geol. Soc., vol. xvii, p. 331, pl. ix, fig. 5.
1869. *Angiopteridium* (?) *strictum*, Schimper, Traité, vol. i, p. 606.
1876. *Glossopteris stricta*, Feistmantel, Rec. Geol. Surv. India, vol. ix, pt. 3, pp. 73, 74.
1880. *G. stricta*, Feistmantel, Flora Gondw. Syst., vol. iii, pts. 2, 3, p. 100, pl. xxxvii A, figs. 1–2; pl. xxxviii A, fig. 3.
1882. *G. stricta*, Feistmantel, ibid., vol. iv, pt. 1, p. 33, pl. xxi, fig. 11.
1889. ? *G. stricta*, Feistmantel, Abhand. böhm. Gesell. Wiss. Prag, ser. VII, vol. iii, p. 45, pl. iv, figs. 6, 6*a*.
1901. *G. stricta*, Amalitsky, Compt. Rend., vol. cxxxii, p. 591.

Type. No. R. 10,363, Museum Geol. Soc. London.

Frond large, elongate-lanceolate. Apex acuminate. Midrib strong. Secondary nerves arched near their point of origin, and forming two or more series of comparatively broad and short polygonal meshes bordering on the midrib, then bent abruptly, and passing very obliquely towards the margin in a direction almost perpendicular to the midrib. Except near the midrib, the secondary nerves are numerous and close, forming very narrow and transversely-elongate meshes. The fronds measure 25–35 cm. or more in length, and are often 4 cm. broad.

This species is distinguished from *G. indica* by the strictly lanceolate form of the frond, tapering more gradually towards the apex and base; by the contrast in the size and shape of the meshes bordering on the midrib with those of the rest of the lamina; and by the very oblique course of the veins towards the margin at a short distance from the midrib. It is only known from a very few localities in India, of which the Nágpur district is the more important. It is somewhat doubtful if the fronds from Cape Colony ascribed to this species by Feistmantel are identical. *G. stricta* has, however, been recently recorded by Amalitsky from the Permian (Northern Type) of Russia.

V. 7145. Pl. IV, Fig. 1.

A slab showing four almost perfect fronds, of which the most nearly complete is 25 cm. long. Part of one of these is figured on Pl. IV, Fig. 1, showing the midrib composed of a bundle of parallel nerves, and the characteristic lateral nervation. The basal portions of several other leaves are also seen.

Silewáda, 12 miles north of Nágpur, India. *Hunter Coll.*

46,705. A large slab showing several fairly complete fronds, one of which is 23 cm. long, and almost perfect except the apex. The contracted base is well seen. The midrib is broad, and is made up of many parallel, anastomosing nerves. The lateral nervation is strongly arched. Another almost complete frond on the same slab measures 33 cm. long, and is 4 cm. broad at the widest point. The nervation is less distinct than in the former specimen. The margin is in places slightly incurved. Several basal portions of fronds also occur on the same slab, as well as a median portion showing the nervation excellently.

Silewáda, India. *Hunter Coll.*

43,705*b*. A slab showing a number of fronds in which the nervation is somewhat indistinct, some of which probably belong to *G. stricta*, while others may possibly be referred to other species.
Silewáda, India. *Hunter Coll.*

V. 7146. Several fragments of long, lanceolate fronds, probably of this species, showing the nervation clearly. The midribs are thick. The broad meshes bordering on the midrib are well marked.
Near Nágpur, India. *Hunter Coll.*

V. 7144. Very fragmentary fronds, but interesting as probably belonging to this species. The comparatively broad meshes near the midrib are well seen, also the bundles of parallel, anastomosing nerves of which the midrib is composed.
Silewáda, India. *Hunter Coll.*

5. Glossopteris ampla, Dana.

(Text-fig. 20.)

1849. *Glossopteris ampla*, Dana, in Wilkes' U.S. Explor. Exped , vol. x, p. 717, pl. xiii, figs. 1*a*, 1*b*.
G. (?) *cordata*, Dana, ibid., p. 718, pl. xiii, fig. 5.
1861. *G. musæfolia*, Bunbury, Quart. Journ. Geol. Soc., vol. xvii, p. 329, pl. viii, fig. 6.
1869. *Macrotæniopteris musæfolia*, Schimper, Traité, vol. i, p. 612.
1876. *Glossopteris musæfolia*, Feistmantel, Rec. Geol. Surv. India, vol. ix, pt. 3, pp. 73, 74.
1878. *G. ampla*, Feistmantel, Palæontogr., Suppl. iii, p. 91, pl. xi, fig. 2; pl. xii, fig. 7.
G. cordata, Feistmantel, ibid., p. 92.
1879. *G. damudica*, Feistmantel, Flora Gondw. Syst., vol. iii, pt. 1, p. 17.
1880. *G. damudica*, Feistmantel, ibid , vol. iii, pts. 2, 3, p. 105, pl. XXX A, figs. 1, 2; pl. XXXI A, figs. 1–3; ? pl. XXXII A, fig. 1; ? pl. XL A, fig. 6.
G. musæfolia, Feistmantel, ibid., p. 101.
1882. *G. damudica*, Feistmantel, ibid., vol. iv, pt. 1, p. 35.
1883. *G. ampla*, Tenison-Woods, Proc. Linn. Soc. New South Wales, vol. viii, p. 124.
G. (?) *cordata*, Tenison-Woods, ibid., p. 124.
1886. *G. ampla*, Johnston, Papers and Proc. R. Soc. Tasmania for 1885, p. 377.
G. cordata, Johnston, ibid., p. 378.
G. damudica, Feistmantel, Flora Gondw. Syst., vol. iv, pt 2, p. 28, pl. I A, fig. 3; pl. IV A, fig. 1 (right-hand figure); pl. V A, fig. 6.
1888. *G. ampla*, Johnston, Geol. Tasmania, p. 111, pl viii, fig. 3; ? pl. ix, fig. 3; ? pl. x, fig. 1.

1889. *Glossopteris damudica*, var. *stenoneura*, Feistmantel, Abhand. böhm. Gesell. Wiss. Prag, ser. VII, vol. iii, p. 46, pl. iv, figs. 7, 7*a*.
1890. *G. ampla*, Feistmantel, Mem. Geol. Surv. New South Wales, Pal., No. 3, p. 122, pl. xix, figs. 1, 2.
G. cordata, Feistmantel, ibid., p. 124.
1892. *G. ampla*, Jack & Etheridge, Geol. and Pal. Queensland, p. 195, pl. xv, fig. 7.
? *G. ovata*, Johnston, Papers and Proc. R. Soc. Tasmania for 1891, p. 13.
1901. *G. damudica*, var. *stenoneura*, Etheridge, jun., in Anderson, 1st Rep. Geol. Surv. Natal, p. 70.
1902. *G. damudica*, Zeiller, Pal. Indica, N.S., vol. ii, p 13, pl. iv, figs. 5 (pars), 6, 7.
G. ampla, Arber, Quart. Journ. Geol. Soc., vol. lviii, p. 7.

Types. The whereabouts of Dana's type is unknown to me. Type of *G. musæfolia*, Bunbury, No. R. 10,359, Mus. Geol. Soc. London. Types of *G. damudica*, Feistmantel, Nos. 5262–6, 5306, Mus. Geol. Surv. India, Calcutta.

Frond usually large, broadly obovate. Apex obtuse or emarginate. Midrib stout, especially in the lower portion of the frond, but not persisting quite to the apex. Lateral nerves arched at midrib, forming one or two series of comparatively broad and short meshes, and then subdividing into a number of close, almost parallel veins, often very oblique, forming extremely narrow, elongate meshes.

The characters which especially distinguish this species are the breadth of the fronds, the stoutness of the midrib, and the contrast between the fine, close, and pseudo-parallel nervation of the greater portion of the lamina, and the nervation bordering on the midrib.

It seems clear from a re-examination of these broad-leaved Glossopterids that *G. damudica*, Feist., must be united with Dana's *G. ampla*. Although Feistmantel's name is the best known, Dana's, as being the older, should have priority. The only difference which I can find between these fronds is that the nervation in the Indian leaves (*G. damudica*) is rather more acute than in the Australian specimens, where the obliquity is very marked in the greater portion of the frond. I am unable, however, to attach any weight to this character. I have had an opportunity of comparing the fine specimens of the Australian fronds in the Clarke Collection of the Sedgwick Museum, Cambridge, with the

British Museum examples of the Indian frond, and this comparison has tended to confirm this conclusion.

I have recently re-examined the type-specimen of Bunbury's

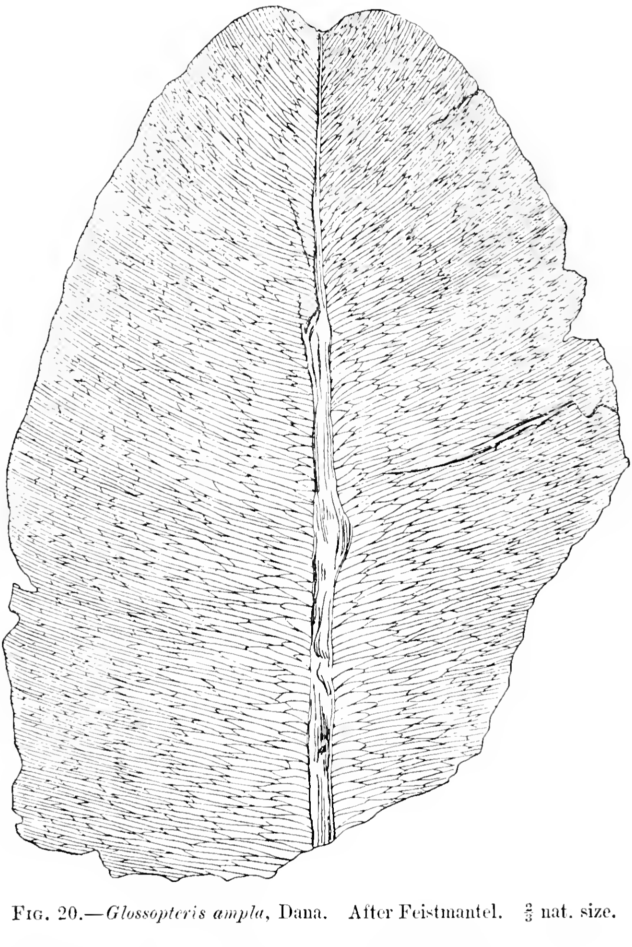

FIG. 20.—*Glossopteris ampla*, Dana. After Feistmantel. $\frac{2}{3}$ nat. size.

G. musæfolia, which I believe to be identical with Feistmantel's species and with *G. ampla*.

As in other species of *Glossopteris*, the fronds of *G. ampla* show

considerable variations in size. Zeiller[1] has recently figured some Indian specimens, barely 2 cm. broad, pointing out, however, that the type of nervation remains fairly constant.

The specimen figured by Dana[2] as *G.* (?) *cordata* is simply a basal portion of a frond of this species. Dana himself admitted that the nervation is very similar to that of *G. ampla*.

I think it probable that the frond termed *G. ovata* by Johnston[3] should also be included here. No figure has been published of this Tasmanian leaf, and it is therefore not easy to arrive at any decision on this point, but the author states that it appears to differ only in details from *G. ampla*. Johnston's specimen was obtained from the Henty River, Tasmania.

Distribution.—Permo-Carboniferous (Glossopteris flora):—India, in the Talchir and Damuda divisions; New South Wales, in the Newcastle Series; Queensland; Tasmania (Mersey River); Cape Colony, Natal, ? Rhodesia.

Fronds of Glossopteris ampla from India.

V. 7141. A fragment of a frond, measuring 7·5 cm. in length, and rather more than 5 cm. across. The midrib is stout. The characteristic nervation of this species, consisting of a few rows of comparatively broad meshes bordering on the midrib, and a much finer, closer, and sub-parallel nervation towards the margin, is well seen in this specimen.

Nágpur, India. *Hunter Coll.*

46,705*a*. A fine frond, measuring 27 cm. long and 8 cm. broad at its widest part. The midrib is stout, the lateral nervation very oblique and almost at right angles to the midrib. The larger meshes near the midrib are well seen. Portions of other fronds occur on the same specimen, which probably also belong to this species; one being a fairly complete leaf, and another a basal portion of a frond.

Silewáda, 12 miles north of Nágpur, India. *Hunter Coll.*

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[1] Zeiller (02[1]), p. 14, pl. iv, figs. 5 (pars), 6, 6*a*.
[2] Dana (49), p. 718, pl. xviii, fig. 5.
[3] Johnston (92), p. 13.

Fronds of Glossopteris ampla from Australia.

V. 2108*a*. A specimen showing several imperfect fragments of large fronds probably identical with this species. One of these measures 23 cm. in length, and 12·5 cm. across. The meshes are very elongate, the nerves being close, and almost parallel.

Pres. by Sir C. Purdon Clarke, 1889.

V. 2108*b*. Similar fragments in which the nervation is more clearly preserved. The meshes are broader near the petiole, but very elongate towards the margin.

Pres. by Sir C. Purdon Clarke, 1889.

V. 2109. Fragments of large fronds probably belonging to this species. *Pres. by Sir C. Purdon Clarke*, 1889.

Fronds of Glossopteris ampla from Tasmania.

V. 3776*k*. Part of a broadly oval frond, 12·5 cm. long by 10 cm. broad. The midrib is strongly marked, but the lateral nervation is not very clear. Fragments of *Gangamopteris* also occur on the same specimen.

Mersey River. *Pres. by T. Stephens, Esq.*, 1898.

V. 3776*b*. A slab of shale with many impressions of *Glossopteris* and other leaves, among which there is a frond probably belonging to this species.

Mersey River. *Pres. by T. Stephens, Esq.*, 1898.

V. 3776*a*. Fragments of fronds of this species in association with *G. indica*.

Mersey River. *Pres. by T. Stephens, Esq.*, 1898.

V. 3776*j*. Part of a frond, probably of this species.

Mersey River. *Pres. by T. Stephens, Esq.*, 1898.

Frond of Glossopteris ampla (?) from Rhodesia.

V. 7593. This specimen shows a broad fragment of a frond, probably an apical portion, measuring 8 cm. in length, with a maximum breadth of 4·5 cm. The nervation is fairly well preserved, the lateral nerves being acute and pseudo-parallel, forming very narrow and elongate meshes.

Sisi Siding, Bechuanaland Railway.

Pres. by A. J. C. Molyneux, Esq., 1901.

Frond of Glossopteris, sp., from Natal.

V. 2903. This specimen is labelled *Tæniopteris*, but it is obviously a *Glossopteris*, since the lateral nerves clearly anastomose. It is a broad frond, which must have been 10 cm. or more across. The midrib is missing. The nerves are nearly parallel, and anastomose apparently at long intervals. Although it is not sufficiently perfect to identify specifically, it may be compared with *G. ampla*.

Farm Glencalder (at 6,700 feet s.m.), Newcastle Division.

Pres. by D. Draper, Esq., 1893.

6. Glossopteris retifera, Feistmantel.

(Text-fig. 21.)

1867. ? *Dictyopteris* (?) *simplex*, Tate, Quart. Journ. Geol. Soc., vol. xxiii, p. 141, pl. vi, fig. 6.

1876. *Sagenopteris polyphylla*, Feistmantel, Journ. Asiat. Soc. Bengal, vol. xlv, pt. 2, p. 377, pl. xx, figs. 5, 6.

1880. *Glossopteris retifera*, Feistmantel, Flora Gondw. Syst., vol. iii, pts. 2, 3, p. 103, pl. xxviiiA, figs. 2, 7, 10; pl. xliA, fig. 9.

Sagenopteris polyphylla, Feistmantel, ibid., p. 113, pl. xliA, figs. 3, 4.

1882. *Glossopteris retifera*, Feistmantel, Flora Gondw. Syst., vol. iv, pt. 1, p. 35.

1886. *G. retifera*, Feistmantel, ibid., vol. iv, pt. 2, p. 29, pl. ivA, fig. 1 (left-hand figure).

1889. *G. retifera*, Feistmantel, Abhand. böhm. Gesell. Wiss. Prag, ser. VII, vol. iii, p. 46, pl. iv, fig. 3.

? *G. Tatei*, Feistmantel, ibid., p. 44, pl. iv, fig. 8.

1896. *G. retifera*, Bodenbender, Zeitschr. deutsch. geol. Gesell., vol. xlviii, table opposite p. 772.

1901. *G. retifera*, Etheridge, jun., in Anderson, 1st Rep. Geol. Surv. Natal, p. 70, pl. xiii, figs. 7, 8.

Type. Nos. 5243, 5251, Mus. Geol. Surv. India, Calcutta.

Frond petiolate, of medium size, lanceolate, or oval-lanceolate. Apex acuminate, or (?) obtuse. Midrib distinct, longitudinally furrowed. Lateral nerves arched, forming open, broadly polygonal meshes, not much longer than broad, and approximately of equal size throughout the lamina.

Feistmantel[1] has figured, under the name of *Sagenopteris polyphylla*, impressions of several Glossopterid fronds radiating from

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[1] Feistmantel (80), pl. xliA, figs. 3, 4.

a stem-like structure. I have no hesitation in regarding these as fronds of *G. retifera* attached to a rhizome. Zeiller[1] has already

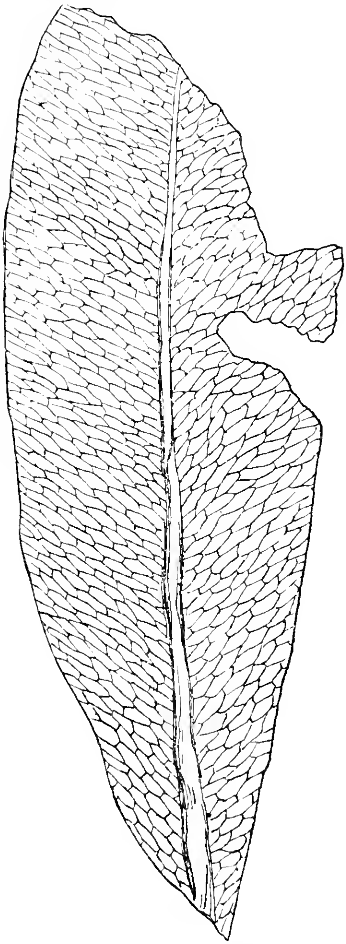

Fig. 21.—*Glossopteris retifera*, Feistmantel. After Feistmantel. Nat. size.

suggested that these specimens should be included in the genus *Glossopteris*.

[1] Zeiller (96[1]), p. 371.

The imperfect specimen with a very oblique nervation figured by Tate[1] in 1867 as *Dictyopteris* (?) *simplex*, may be compared with this species as regards the characters of the meshes. A re-examination of the type, preserved in the Museum of the Geological Society of London (No. R. 11,104), has shown that it is probably a frond of *Glossopteris*, but that the fossil is too fragmentary to permit of specific determination.

Distribution.—Permo-Carboniferous (Glossopteris flora) :—India, in the Damuda division; Cape Colony, Natal, Orange River Colony, and Argentina.

Fronds of Glossopteris retifera from Natal.

V. 2904. Small fragments occur on this specimen in association with *G. Browniana*.

Farm Glencalder (at 6,700 feet s.m.), Newcastle Division.

Pres. by D. Draper, Esq., 1893.

V. 2904*b*. Several well-preserved fragments showing the nervation clearly. One of these is a median portion of a leaf, 5 cm. long and 3 cm. across.

Farm Glencalder (at 6,700 feet s.m.), Newcastle Division.

Pres. by D. Draper, Esq., 1893.

V. 2904*c*. Basal portions of fronds of this species in association with *G. Browniana*.

Farm Glencalder (at 6,700 feet s.m), Newcastle Division.

Pres. by D. Draper, Esq., 1893.

Fronds of Glossopteris retifera from the Orange River Colony.

V. 2902*a*. A number of fragments of fronds of this species in association with those of *G. conspicua*.

Mill River Ford, Harrismith. *Pres. by D. Draper, Esq.*, 1893.

V. 2465. Among the fronds shown on this specimen there are some possibly identical with *G. retifera*, in association with fronds of *G. Browniana* and *G. conspicua*.

Mill River Ford, Harrismith. *Pres. by D. Draper, Esq.*, 1890.

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[1] Tate (67), pl. vi, fig. 2; Feistmantel (89), pl. iv, fig. 8.

7. Glossopteris conspicua, Feistmantel.

(Plate III, Fig. 3; Text-fig. 22.)

1881. *Glossopteris conspicua*, Feistmantel, Flora Gondw. Syst., vol. iii, pt. 3, p. 104, pl. xxviii A, figs. 1, 5, 6, 8, 9.
1886. *G. conspicua*, Feistmantel, ibid., vol. iv, pt. 2, p. 29.
1893. *G. conspicua*, Oldham, Man. Geol. India, 2nd pl. opp. p. 162.

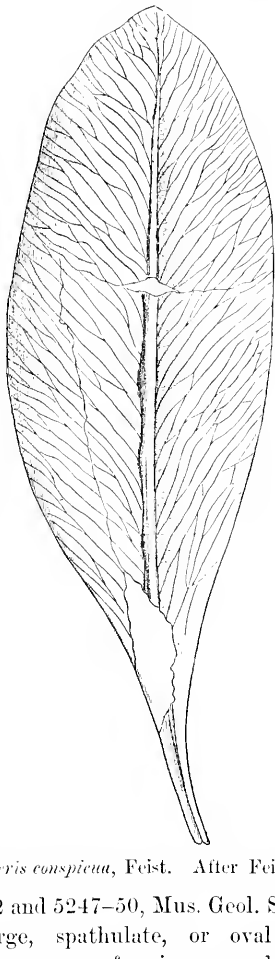

FIG. 22.—*Glossopteris conspicua*, Feist. After Feistmantel. Nat. size.

Type. Nos. 5242 and 5247–50, Mus. Geol. Surv. India, Calcutta.

Frond fairly large, spathulate, or oval-lanceolate. Midrib distinct. Secondary nerves forming very large, open, elongate

meshes of approximately the same size throughout the lamina. Meshes oblong-polygonal, transversely elongate, much longer than broad.

G. conspicua recalls *G. retifera*, but the leaf is generally larger, and the meshes much longer than broad, whereas in the latter species they are comparatively smaller, and more nearly of equal length and breadth.

The meshes in *G. conspicua* are probably larger, and more open (i.e. broader in comparison with their length) than in any other known representative of this genus.

G. conspicua has so far been recorded only from the Raniganj group of the Damuda division in India. Some specimens from the Orange River Colony are, however, here attributed to this species.

Fronds of Glossopteris conspicua from the Orange River Colony.

V. 2465. Pl. III, Fig. 3.

A fairly large, well-preserved, oval-lanceolate frond, in association with fronds of *G. Browniana* and *G. retifera*, of which only a portion is figured on Pl. III, Fig. 3. The leaf measures 9 cm. in length, and has a maximum breadth of 4·4 cm., the basal part being absent. The nervation is very clear, the long but very broad nets recalling the Indian fronds described by Feistmantel. A smaller fragment also occurs on the same specimen.

Mill River Drift, Harrismith. *Pres. by D. Draper, Esq.*, 1890.

V. 2902*a*. Fragments of fronds of this species, occurring in association with *G. retifera*.

Mill River Drift, Harrismith. *Pres. by D. Draper, Esq.*, 1893.

8. Glossopteris formosa, Feistmantel.

1881. *Glossopteris formosa*, Feistmantel, Flora Gondw. Syst., vol. iii, pt. 3, p. 106, pl. xxxixA, figs. 3–7.

1882. *G. formosa*, var. *major*, Feistmantel, ibid., vol. iv, pt. 1, p. 36, pl. xxi, fig. 12.

1886. *G. formosa*, Feistmantel, ibid., vol. iv, pt. 2, p. 26.

Type. Nos. 5292–4, Mus. Geol. Surv. India, Calcutta.

Leaves linear or linear-lanceolate. Apex obtuse. Midrib slender.

Secondary nervation acute, forming broad, oblong-polygonal meshes, of approximately the same size throughout the lamina.

G. formosa appears to be a narrow-leaved type of frond corresponding to *G. retifera* or *G. conspicua*, in the same way as *G. angustifolia* probably corresponds to *G. indica.* It is possible that in each case both the narrow and broad-leaved fronds may have belonged to the same plant.

G. formosa is known only from the Raniganj group of the Damuda division in India.

Not represented in the British Museum collection.

9. Glossopteris tortuosa, Zeiller.

1902. *Glossopteris tortuosa*, Zeiller, Pal. Indica, N.S., vol. ii, p. 14, pl. iii, figs. 2, 2*a*.

Type. No. 7267, Mus. Geol. Surv. India, Calcutta.

Frond of medium size, contracting gradually towards the base; median nerve strong, with longitudinal striations; secondary nerves thick, spreading, irregularly sinuate, forming on each side of the midrib two series of large, polygonal meshes, the succeeding meshes being narrower, more elongate, polygonal, or trapezoidal.

Zeiller has recently founded this species on a single specimen from India. It recalls the fronds of *G. Browniana* or *G. indica*, but the median nerve is stronger and is longitudinally striated, while the lateral nerves, which are flat and broad near the midrib, thinning gradually towards the margin, are almost at right angles to the midrib. The lateral nerves are sinuate, and anastomose at intervals, giving rise to a network, of which the two series of meshes next the midrib are broadly polygonal, the more distal being narrower and more elongate, sometimes truncate, sometimes narrowed to a point at their extremities.

In their nervation, these fronds may be also compared with the Indian leaves referred to Feistmantel's species *G. damudica*, which is here included with *G. ampla*, Dana. Zeiller does not, however, regard them as identical.

Glossopteris tortuosa is known only from the Raniganj group of the Damuda division in India.

Not represented in the British Museum collection.

10. Glossopteris divergens, Feistmantel.

(Text-fig. 23.)

1881. *Glossopteris divergens*, Feistmantel, Flora Gondw. Syst., vol. iii, pt. 3, p. 104, pl. xxviii A, figs. 3, 4.

Type. Nos. 5244–5, Mus. Geol. Surv. India, Calcutta.

This species is known only from a single imperfect specimen, of which the following appear to be the chief characters.

Frond (?) ovate. Midrib strong. Secondary nerves very oblique, almost at right angles to the midrib in the median portion of the

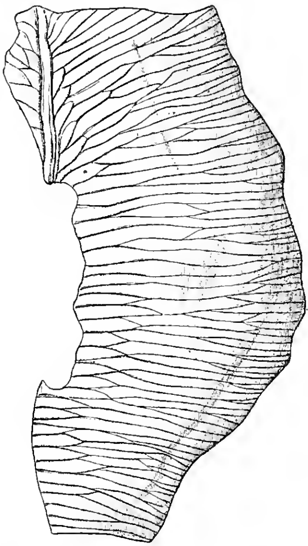

FIG. 23.—*Glossopteris divergens*, Feist. After Feistmantel. Nat. size.

frond, becoming even more oblique towards the base, but less so towards the apex. The course of the secondary nerves is sinuous or tortuous, the meshes being of irregular shape, but fairly broad, and rather longer than broad.

Feistmantel in his description of this species does not mention the flexuous character of the secondary nerves, which must be very conspicuous if the drawing which he gives (Text-fig. 23) is faithful to the original. Provided also this feature is not due

to an accident of preservation, it probably forms an important character of this frond. That the nerves in certain Glossopterids may be sinuous has been recently shown by Zeiller (see *G. tortuosa*).

G. divergens is known only from the Raniganj group of the Damuda division in India.

Not represented in the British Museum collection.

11. Glossopteris decipiens, Feistmantel.

(Text-fig. 24.)

1879. *Glossopteris decipiens*, Feistmantel, Flora Gondw. Syst., vol. iii, pt. 1, p. 17, pl. xviii, figs. 3–5, pl. xxiv, fig. 6.
? *Sagenopteris* (?) *Stolıczkana*, Feistmantel, ibid., p. 18, pl. xiii, fig. 4.
1880. *Glossopteris decipiens*, Feistmantel, ibid., vol. iii, pts. 2, 3, p. 107.
? *Sagenopteris* (?) *Stoliczkana*, Feistmantel, ibid., p. 114.
1886. *Glossopteris decipiens*, Feistmantel, ibid., vol. iv, pt. 2, p. 29.

Type. Nos. 5025 and ? 5012, Mus. Geol. Surv. India, Calcutta.

Frond narrowly spathulate, base truncate (?), basal angles rounded, or sub-auriculate. Midrib strong, hardly extending for more than two-thirds of the length of the leaf, breaking up above into radiating and anastomosing secondary nerves. Secondary nervation arising at an acute angle, forming narrow, oblong meshes.

The general character of the secondary nervation appears to me to be closely similar to that of *G. indica.* The frond is, however, distinguished by the fact that the midrib does not extend for more than two-thirds of the length of the leaf, and by the truncated base, the lateral angles of which are slightly auriculate. As Feistmantel has pointed out, this species seems to present a transitional type between *Glossopteris* and *Gangamopteris.* It is also especially interesting as being one of the earliest members of the genus to appear in India, in rocks which are probably equivalent in age to the Upper Carboniferous deposits of Europe.

It is remarkable that among the earliest Glossopterid fronds from Australia, there also appear to be some in which the midrib is impersistent, and dissolves into lateral veins at some distance from the apex. It is not improbable that when these early forms are better known, this character may be found to be of some

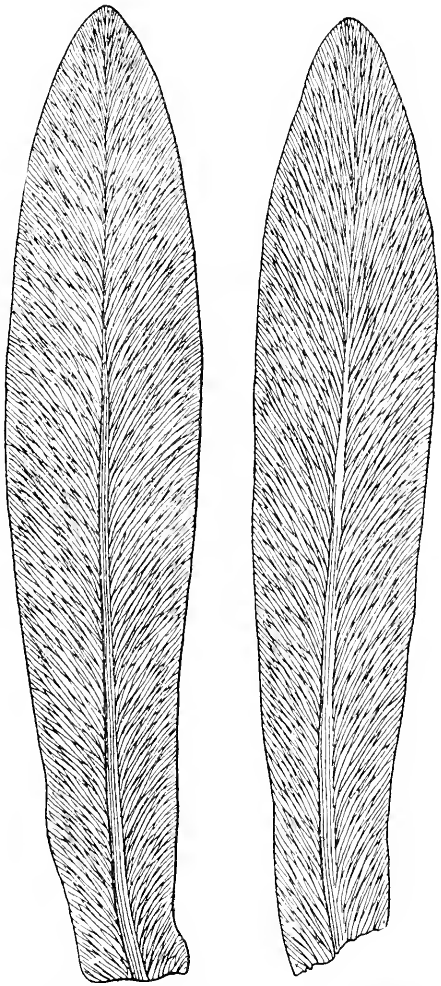

FIG. 24.—*Glossopteris decipiens*, Feist. After Feistmantel. $\frac{3}{4}$ nat. size.

significance. Feistmantel[1] has figured a very imperfect fragment from the "Lower Coal Measures" of Greta, New South Wales,

[1] Feistmantel (90), p. 124, pl. xii, figs. 3, 3*a*, and (78), p. 155, pl. viii, figs. 2, 2*a*. Also identified by Johnston (86), p. 378; Tenison-Woods (83), p. 125; and Shirley (02), p. 13.

under the name *G. elegans*, which, in the characters of the midrib and nervation generally, offers a close comparison with the Indian species under consideration. It is, however, impossible, on such imperfect evidence, to arrive at any conclusion as to the identity of these two fronds, and for the present *G. elegans* can hardly rank as a well-defined species. With these species may be also compared Feistmantel's *G. gangamopteroides* (see p. 53) from New South Wales.

The Indian specimens figured by Feistmantel[1] as *Sagenopteris* (?) *Stoliczkana* are undoubtedly *Glossopteris* fronds, and very possibly leaves of *G. decipiens*.

Glossopteris decipiens is known only from the Karharbári Series of the Talchir division of India.

Not represented in the British Museum collection.

12. Glossopteris longicaulis, Feistmantel.

1881. *Glossopteris longicaulis*, Feistmantel, Flora Gondw. Syst., vol. iii, pt. 1, Suppl., p. 53, pl. xxxi, figs. 1, 3.

Type. Nos. 5084 and 5086, Mus. Geol. Surv. India, Calcutta.

Frond oblong-oval, with a long petiole. Midrib distinct in the lower part of the frond, but evanescent above. Secondary nervation arising at a sub-acute angle, forming somewhat broad, oblong meshes.

This frond is only known from the Karharbári Series in India. Its chief distinguishing characters appear to be the long petiole, and impersistent midrib.

Not represented in the British Museum collection.

13. Glossopteris orbicularis, Feistmantel.

(Text-fig. 25.)

1880. *Glossopteris orbicularis*, Feistmantel, Flora Gondw. Syst., vol. iii, pts. 2, 3, p. 107, pl. xli A, figs. 1, 2.

Type. No. 5307, Mus. Geol. Surv. India, Calcutta.

Frond orbicular, sub-emarginate, petiolate. Median nerve strong

[1] Feistmantel (79[1]), p. 18, pl. xiii, fig. 4.

in the lower portion of the leaf, but dissolving into fine veins towards the apex. Lateral nervation acute, arched. Meshes wide, oblong-polygonal.

Feistmantel has suggested that this almost circular frond may be only an immature stage of some other species. It is known from two localities in the Raniganj group of the Damuda division of India. The same author[1] has, however, described, under the name *G. spathulato-cordata*, some very similar fronds from the Newcastle Series of New South Wales, and from Tasmania. So far

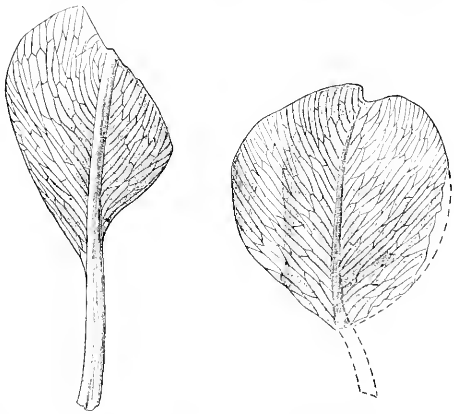

Fig. 25.—*Glossopteris orbicularis*, Feist. After Feistmantel. Slightly reduced.

as one can judge from a comparison of his figures, the latter specimens, although smaller, have a similar nervation, and may eventually prove to be identical.

Not represented in the British Museum collection.

THE RHIZOME OF *GLOSSOPTERIS*.

Genus **VERTEBRARIA**, Royle, 1833.

[Illust. Bot. Himal. Mounts., p. xxix*.]

Elongate, flattened, cylindrical casts, simple or branched, often bearing root-like organs.

In specimens preserved more or less perpendicular to the bedding-

[1] Feistmantel (90), p. 128, pl. xx, figs. 5, 7, 8.

planes of the rock, the axis, as seen in transverse section, is composed of a number of compact, wedge-like sectors, radiating from a common centre. Between the sectors, and sometimes external to the broad faces of the wedges, a thin film of carbonaceous material is found.

In specimens preserved approximately parallel to the bedding-planes, the cast, as seen in surface view, is formed of two or three longitudinally disposed series of oblong or almost square areas. When two series of areas only are present they are separated by a longitudinal groove or ridge. Where three series are found two longitudinal grooves may occur, but they are often less well-marked than in the former case. In many specimens the areas of one series slightly overlap those of another. The areas are often striated longitudinally, the striæ being fairly distant.

The areas of each longitudinal series are separated from one another by transverse grooves, the grooves of any two parallel series being very rarely, if ever, opposite. In most specimens each area has a well-marked transverse ridge, which varies greatly in position. The length of the area, i.e. the distance between two transverse grooves, also varies considerably in the same series, and in two parallel series. The same cast may show three series of areas in one part, and only two in another. The root-like organs arise at the transverse folds, and are highly branched structures.

Vertebraria occurs in the form of casts presenting features quite unlike any of the associated fossils, and much speculation has arisen as to the affinities of this plant. Royle, who instituted the genus, speaks of it as the "Ranigunj Reed." Bunbury[1] was inclined to regard it as a root or rhizome of an Equisetalian plant, a view which Feistmantel at one time also shared to some extent. McCoy[2] suggested that these fossils originated from plants bearing slender, jointed stems, surrounded by compact whorls of six to twelve wedge-shaped leaves. All doubts were, however, set at rest in 1896, when Zeiller[3] discovered that *Vertebraria* was neither more nor less than the rhizome of

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[1] Bunbury (61), p. 339.

[2] McCoy (47), p. 146.

[3] Zeiller (96^3) and (96^1), pl. xv, figs. 8, 9.

Glossopteris, a discovery which was confirmed almost simultaneously by Oldham.[1] In both cases fronds of *Glossopteris* were found in continuity with *Vertebraria*.[2]

Previously to Zeiller's discovery, several observers had described fronds of *Glossopteris* attached to an axis, usually extremely fragmentary, or at any rate not possessing the well-known features of *Vertebraria*. McCoy,[3] in 1847, stated that he believed he had "ascertained the rhizoma of this species" (*G. Browniana*); but he did not give any particulars of his discovery. In 1849 Dana[4] figured a number of petiolate fronds of *Glossopteris* attached to a rhizome, and, in his great memoir on the Flora of the Lower Gondwana Series, Feistmantel[5] figured several others. But the figures published by Etheridge[6] in 1894 are more important. The specimen described was obtained from Mudgee, New South Wales, and showed several leaves of *Glossopteris Browniana* in continuity with a stem structure, described as a caudex by that author, which presented none of the features characteristic of *Vertebraria*. This specimen will be further discussed here.

The explanations offered of the peculiar features exhibited by this fossil have been varied. That suggested by Solms-Laubach[7] was that these rhizomes were cylindrical organs with a solid axis surrounded by lacunæ, which were bridged here and there by transverse diaphragms of tissue, connecting the cortical tissues with the central axis. That offered by Zeiller[8] in 1896 is much more elaborate. He concludes that the features of *Vertebraria* are derived as casts of the external surface of a winged rhizome. He compares it with the rhizome of such a fern as *Struthiopteris germanica*, Willd., in which a variable number of prominent, projecting, longitudinal wings occur, which anastomose with one another at different levels. The areas which form such a characteristic feature of the fossil as seen in surface view, are the interpolations of the matrix of the rock between the wings

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[1] Oldham (97), pl. iii.

[2] A specimen showing continuity between these two organs has since been found in the Clarke Collection in the Sedgwick Museum, Cambridge.

[3] McCoy (47), p. 151.

[4] Dana (49), p. 716, pl. xii, fig. 13*c*.

[5] Feistmantel (80), pl. xl A, fig. 1; pl. xli A, fig. 3.

[6] Etheridge & David (94).

[7] Solms-Laubach (91), p. 366.

[8] Zeiller (96^1), p. 351; (96^3).

of the rhizome, which in the fossil state are sometimes represented by a small amount of carbonaceous material, while the transverse grooves may be explained as the points of anastomosis of two of the wings at short intervals. Zeiller also figures fronds attached at the transverse grooves, and in other instances he finds a print of the attachment of a leaf in a similar position.

In 1897 Oldham[1] published an account of a specimen of *Vertebraria* from India, to which a number of fronds, probably of *Glossopteris indica*, were attached, thus confirming Zeiller's conclusion as to the nature of this fossil. At the same time Oldham pointed out that his specimens of *Vertebraria*[2] did not agree in all particulars with those described by Zeiller, and he doubted whether the explanation of the morphological features of the fossil put forward by that author was entirely correct. In particular, he pointed out that in some of the Indian specimens, as seen in transverse section, a shell of coaly matter, which was apparently wanting in the South African specimens, was present outside the wedge-like sectors. He concludes that *Vertebraria* must have been a stem with a central axis connected with some outer tissues by radiating, longitudinally disposed plates or septa, which were usually eight in number, in addition to numerous transversely placed septa, which divided up the lacunæ between the longitudinal septa into chambers.

In 1902 Zeiller[3] replied to Oldham's criticism, and maintained his explanation, pointing out that the small traces of a carbonaceous layer outside the wedges, which are found in some specimens as seen in transverse section, correspond with the points of anastomosis of two wings of the rhizome.

It must be admitted that Zeiller's explanation of *Vertebraria* is the best which has so far been put forward. Yet, without attempting to criticise it in detail, I am not entirely convinced that the morphological features of that fossil are directly due to the structure of the *external* surface of a rhizome. It must be remembered that Etheridge,[4] in 1894, figured a specimen showing some fronds of *Glossopteris Browniana* attached to an axis, which

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[1] Oldham (97), pl. iii.
[2] Oldham (97), pls. iv, v.
[3] Zeiller (02[1]), p. 17.
[4] Etheridge & David (94), p. 228, pl. xviii, fig. 1; pl. xix, figs. 1, 2.

appears to me to be of the nature of a rhizome, but which, obviously, is not a *Vertebraria*. The Australian specimen has exactly the appearance that one would expect the external surface of a rhizome to present. It is a cylindrical axis on which may be seen numerous prints or leaf-scars. Similar organs have also been described elsewhere in association with the Glossopteris flora. Feistmantel[1] has figured one from India; and one from Port Stephens, New South Wales (V. 7206, *Odinheimer Coll.*), is figured here on Plate VI, Fig. 4. The latter specimen occurs on a piece of yellowish-white shale, on the back of which are found several fragments of fronds of *G. Browniana*, and a small portion of a *Vertebraria*. The two cylindrical bodies figured appear to be axes, on which may be seen numerous depressions having all the characteristics of leaf-scars, the vascular prints being clearly visible here and there. They were no doubt stem structures bearing crowded, almost overlapping leaves, and there is every probability that an impression of the true external surface is preserved. There is, however, no absolute proof that this specimen belonged to *Glossopteris*, although it somewhat resembles that figured by Etheridge.

In view of this evidence it would appear to me more probable that the characteristic features of *Vertebraria* may be due to the internal, and not to the external structure of a rhizome; a structure with which we are at present entirely unacquainted, unfortunately, owing to the absence of petrified material. In this case we should be dealing with an internal and not an external cast. It may be that impressions of the external features of these rhizomes were rare as compared with the internal, just as in the case of the stems of *Calamites*. Whether this provisional suggestion is likely to prove correct remains to be seen. In the meanwhile there is room for still further research into the origin of the features presented by this puzzling fossil, *Vertebraria*.

Vertebraria indica, Royle.

(Pl. IV, Figs. 2–4.)

1833. *Vertebraria indica*, Royle, Illust. Bot. Himal. Mounts., p. xxix*, pl. ii, figs. 1–3.

V. radiata, Royle, ibid., p. xxix*, pl. ii, figs. 5–7.

[1] Feistmantel (79[1]), pl. xiii, fig. 6.

1847. *Vertebraria australis*, McCoy, Ann. & Mag. Nat. Hist., vol. xx, p. 147, pl. ix, fig. 1.
1849. *Clasteria australis*, Dana, in Wilkes' U.S. Explor. Exped., vol. x, p. 719, pl. xiv, figs. 3–5.
1850. *Vertebraria indica*, M'Clelland, Rep. Geol. Surv. India, pl. xiv, figs. 1, 1*a*.
Sphenophyllum australe, Unger, Gen. et Spec. Plant. foss., p. 72.
S. indicum, Unger, ibid., p. 71.
S. radiatum, Unger, ibid., p. 71.
1861. *Vertebraria* (?), Bunbury, Quart. Journ. Geol. Soc., vol. xvii, p. 338, pl. xi, fig. 3.
1876. *Vertebraria indica*, Feistmantel, Journ. Asiat. Soc. Bengal, vol. xlv, pt. 2, p. 347, pl. xv, fig. 3; pl. xvi, fig. 4.
1878. *V. australis*, Feistmantel, Palæontogr., Suppl. iii, p. 84, pl. vi, figs. 1, 2; pl. vii, figs. 1, 2.
1879. *V. indica*, Feistmantel, Flora Gondw. Syst., vol. iii, pt. 1, p. 8, pl. i, figs. 8, 9.
1880. *V. indica*, Feistmantel, Flora Gondw. Syst., vol. iii, pts. 2, 3, p. 72, pl. xii A, figs. 10, 11; pl. xiii A, figs. 1–6; pl. xiv A, figs. 1–4; pl. xiv A *bis*, fig. 3.
1882. *V. indica*, Feistmantel, Flora Gondw. Syst., vol. iv, pt. 1, p. 22, pl. xi, figs. 1–4.
1883. *V. australis*, Tenison-Woods, Proc. Linn. Soc. New South Wales, vol. viii, p. 75.
1886. *V. indica*, Feistmantel, Flora Gondw. Syst., vol. iv, pt. 2, p. 22, pl. iv A, figs. 4, 5, 7–11; pl. v A, fig. 1; pl. xiii A, fig. 8.
V. australis, Johnston, Papers and Proc. R. Soc. Tasmania for 1885, p. 364.
1888. *V. indica*, Schenk, Foss. Pflanzenr., p. 188.
1890. *V. australis*, Feistmantel, Mem. Geol. Surv. New South Wales, Pal. No. 3, p. 87; pl. xiv, fig. 6; pl. xv, figs. 1–3.
1891. *V.* sp., Solms-Laubach, Foss. Botany, Eng. ed., pp. 365–6.
1893. *V. indica*, Oldham, Man. Geol. India, pl. opp. p. 162.
1896. *V. indica*, Zeiller, Bull. Soc. Géol. France, ser. III, vol. xxiv, p. 351, pl. xv, figs. 1–9.
1897. *V. indica*, Oldham, Rec. Geol. Surv. India, vol. xxx, pt. 1, pp. 45, 49, pl. iv, figs. 1–5; pl. v, figs. 1–4.
1900. *V. indica*, Zeiller, Élém. Paléobot., p. 114, text-fig. 87.
? *V.* sp., Potonié, in Deutsch. Ost-Afrika, vol. vii, p. 499, figs. 23, 24.
1901. *V. indica*, Arber, Geol. Mag., dec. IV, vol. viii, p. 547.
1902. *V. indica*, Zeiller, Pal. Indica, N.S., vol. ii, p. 17, pl. v, figs. 1–7.
1903. *V. australis*, Arber, Quart. Journ. Geol. Soc., vol. lviii, p. 8.

Type. No. V. 4189, Geol. Dept. British Museum (Nat. Hist.).

There is, I believe, only one species of *Vertebraria* known, *V. indica*, and consequently the characters of the species are those of the genus.

I have here united *V. australis* with *V. indica*, since there do not appear to be any good characters which clearly separate them. Even Feistmantel admitted that these two species were closely similar. Tenison-Woods[1] has described two species from the Mesozoic rocks of Queensland, but it is more than doubtful if they have any claims to be included in the genus, as Zeiller has already pointed out. The fossil described by Schmalhausen[2] as *V.* (?) *petschorensis* is almost certainly not a true member of the genus.

Royle, who first described the Indian species, assigned two separate names, *V. indica* and *V. radiata*, to the same fossil as seen in surface view and transverse section respectively. Curiously enough the same thing happened with regard to the Australian fossils, McCoy's *V. australis* being a specimen showing the transverse section, and Dana's *Clasteria australis* representing the same plant as seen in surface view.

Specimens of Vertebraria indica from India.

V. 4189. Pl. IV, Fig. 2; also figured by Royle (33), pl. ii, fig. 1. *Type.*

Of the six specimens of *Vertebraria* figured by Royle, only one has been identified, and this is the more important of those described under the name *V. indica.* It measures 15 cm. in length, and 1·8 cm. across. The median groove is well marked, and the areas between the transverse furrows on either side are almost square (9 mm. long and broad), or slightly oblong (6 × 16 mm.). Transverse ridges also occur. The upper portion of the cast is probably imperfect.

Bardwán Coalfield.

V. 7191. A specimen rather more than 10 cm. long, and about 2 cm. broad, showing the longitudinal and transverse grooves and the transverse ridges.

Near Nágpur. *Sankey Coll.*

Specimens of Vertebraria indica from New South Wales.

V. 7208. Pl. IV, Fig. 3.

A specimen measuring nearly 9 cm. in length, and 2·5 cm. in

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[1] Tenison-Woods (83), pp. 80–1, pl. i, figs. 1–4.

[2] Schmalhausen (79), p. 53, pl. vii, figs. 14–18.

breadth, with a well-marked, somewhat flattened median ridge, formed by the compression of a median series of areas. The transverse ridges and grooves of the lateral areas alternate on either side of the ridge, and occur at very unequal distances from each other. On the right-hand side of the specimen as seen in the figure, the oblong areas between the four transverse grooves overlie the areas of the median ridge. Four transverse ridges are also seen which appear to correspond with the transverse ridges of the median series, whereas the grooves do not correspond. On the left-hand side three ridges and grooves are seen. The longitudinal ridge is flattened over some of the areas on this side.

Port Stephens. *Odinheimer Coll.*

V. 7212. Pl. IV, Fig. 4.

A specimen showing two fragments of *Vertebraria*, of which one is figured here. There is no longitudinal groove or ridge, but a median series of areas, which is overlapped by both the lateral rows of areas. The transverse furrows of the median series do not correspond with those of either of the lateral series. Three ridges are seen in the median row. As figured here, the right-hand lateral series shows five areas, and the left-hand three, on which well-marked, but distant striæ occur.

Port Stephens. *Odinheimer Coll.*

V. 4286. Two series of areas, separated by a median groove, are seen in this specimen for a considerable portion of its length, but at one end there is simply a single row of larger areas, which are striated longitudinally.

Port Stephens. *Odinheimer Coll.*

V. 7210. A small piece of a rhizome, showing a longitudinal groove and two series of areas with transverse ridges and grooves. The areas are faintly striated longitudinally. Fragments of scale-fronds are associated with this specimen.

Port Stephens. *Odinheimer Coll.*

V. 7209. A specimen of *Vertebraria*, some 9 cm. in length. The longitudinal groove is indistinct, but there are two series of areas, with well-marked transverse grooves and ridges. The areas are also striated longitudinally, the striæ being fairly distant from each other, about 1 mm. apart. Several fronds of *Glossopteris Browniana* are also associated.

Port Stephens. *Odinheimer Coll.*

V. 4203. A fragment of a rhizome with plainly-marked median and lateral grooves, associated with fronds of *Glossopteris Browniana*.

Port Stephens. *Odinheimer Coll.*

V. 7290. A portion of a *Vertebraria* with rootlets, also associated with fronds of *Glossopteris Browniana*, showing the nervation clearly.

Port Stephens. *Odinheimer Coll.*

Other specimens:—**V. 4285, V. 7203, ? V. 7223.** Port Stephens, New South Wales; *Odinheimer Coll.*

Roots and Rootlets of Uncertain Affinity.

Specimens of roots or rootlets are occasionally found associated with members of the Glossopteris flora. Some of these no doubt may be attributed to *Vertebraria*, while others belong to plants whose nature it is impossible to decide. Some of the specimens to which Dana gave the names *Austrella rigida*,[1] *Conferrites* (?) *tenella*,[2] *Cystoseirites*, sp.,[3] are probably of this nature. The term *Pustularia calderiana*, Royle,[4] is a *nomen nudum*.

Specimens of Roots, etc.

V. 7192. A piece of sandstone with a number of highly branched roots or rootlets, with some trace of a main axis.

? India.

V. 7134. Fragments of branched root-like structures.

Near Kamthi, India. *Hunter Coll.*

V. 7198. A root, bearing rootlets.

Nágpur, India. *Sankey Coll.*

V. 239. A root or rhizome.

Beaufort Series, Zwartkei River, Cape Colony.

V. 2112. Fragments of rootlets resembling the specimens from India, above described.

Bowenfels, New South Wales.

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[1] Dana (49), p. 720, pl. xiv, figs. 7, 8.
[2] Dana (49), p. 720, pl. xiv, fig. 9.
[3] Dana (49), p. 720, pl. xiv, fig. 6*a*.
[4] Royle (33), p. xxix* ; see also Arber (01), p. 549.

V. 2909. Several root-like structures with median grooves, associated with fragments of rootlets.

Farm Glencalder (at 6,700 feet s.m.), Newcastle Division, Natal.

Pres. by D. Draper, Esq., 1893.

V. 2906. Fragments of a rhizome-like structure, and of rootlets.

Farm Glencalder (at 6,700 feet s.m.), Newcastle Division, Natal.

Pres. by D. Draper, Esq., 1893.

V. 2905, V. 2905*a*, V. 2905*d*. Numerous fragments of rootlets, in association with *Glossopteris*.

Farm Glencalder (at 6,700 feet s.m.), Newcastle Division, Natal.

Pres. by D. Draper, Esq., 1893.

V. 8318. A piece of sandy shale, largely composed of root-like structures, bearing lateral rootlets. The details of the external morphology are not very clear.

Candiota, Rio Grande do Sul, Brazil.

Pres. by J. Mawson, Esq., 1894.

V. 8316, V. 8316*a*, V. 8317. Smaller fragments, similar to the last specimen, consisting chiefly of lateral rootlets.

Candiota, Rio Grande do Sul, Brazil.

Pres. by J. Mawson, Esq., 1894.

Genus **GANGAMOPTERIS**, McCoy, 1861.

[Trans. Roy. Soc. Victoria, vol. v (1860), p. 107, note.]

Frond simple, entire, greatly varied in shape, elliptical, broadly and elongately obovate, broadly lanceolate, sub-linear, etc., contracted towards the base. Midrib absent. Median nerves more or less parallel, anastomosing; lateral nerves arising by repeated dichotomy from the median nerves or from the base, arched, bifurcating, and anastomosing to form a network.

The chief feature in which *Gangamopteris* differs from *Glossopteris* is the absence of a definite midrib, the median portion of the leaf being usually traversed by a group of almost parallel, anastomosing nerves. The anastomosing lateral nervation is very similar in both genera, and almost as great variations are found in *Gangamopteris* as in *Glossopteris*, in the habit and details of the nervation, even

in fronds which were probably borne by one and the same plant. In some cases it is questionable whether it is possible to distinguish clearly between the two genera.[1]

Nothing is known as to the fructification of any member of the genus, nor has it been ascertained whether the fronds are dimorphic like those of *Glossopteris*. Feistmantel[2] has figured some very small fronds, recalling the scale-fronds of *Glossopteris*, which he referred to *Gangamopteris*, but whether they should be regarded as belonging to the former genus rather than the latter there is no evidence at present to show.

The specimen originally described by McCoy in 1847 as *Cyclopteris angustifolia*, on which the genus is founded, is preserved in the Sedgwick Museum, Cambridge.

Distribution.—*Gangamopteris* is perhaps as widely distributed in the Permo-Carboniferous rocks of Gondwanaland as *Glossopteris*, although it is not of such common occurrence nor so generally abundant. In South America it occurs in both Brazil and Argentina, whereas *Glossopteris* has been only comparatively recently discovered in the latter country. In Victoria, Australia, *Glossopteris* is unknown, while several species of *Gangamopteris* are found. In India it appears to be more abundant than *Glossopteris* in the lowest member of the Gondwana Series, the Talchir-Karharbári Beds, though in the "Lower Coal Measures" of New South Wales, of approximately the same age, it is unknown, whereas several Glossopterids occur. Otherwise it occurs in almost all the divisions of the Permo-Carboniferous rocks in various parts of the world from which the Glossopteris flora is known. It has not, however, been recorded from beds of Mesozoic age.

Permo-Carboniferous (Glossopteris flora):—India, in the Talchir and Damuda divisions; Kashmir; New South Wales, in the Newcastle Series; Victoria; Tasmania; S. Africa, Transvaal; South America, Brazil and Argentina. *Permian* (Northern Type):—Russia.

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[1] See Etheridge & David (94), pp. 240–1.

[2] Feistmantel (79[1]), pl. ix, fig. 4; pl. x, fig. 3; (81), pl. xxxix A, fig. 9.

1. Gangamopteris cyclopteroides, Feistmantel.

(Pl. III, Figs. 4, 5; Text-fig. 26.)

1869. *Noeggerathia obovata*, Carruthers, Geol. Mag., vol. vi, p. 155, pl. vi, fig. 1.

1875. *Gangamopteris spatulata*, McCoy, Prodr. Palæont. Victoria, dec. II, p. 12, pl. xiii, figs. 1, 1*a*.

G. obliqua, McCoy, ibid., p. 13, pl. xii, figs. 2–4.

1876. *G. cyclopteroides*, Feistmantel, Rec. Geol. Surv. India, vol. ix, pt. 3, pp. 73, 78.

1878. *G. spathulata*, Feistmantel, Palæontogr., Suppl. iii, p. 102.

G. obliqua, Feistmantel, ibid., p. 102.

G. Clarkeana, Feistmantel, ibid., p. 93, pl. xv, fig. 9.

1879. *G. cyclopteroides*, Feistmantel, Flora Gondw. Syst., vol. iii, pt. 1, p. 12, pl. vii; pl. viii; pl. ix, figs. 1–3, 6; pl. xi, figs. 2–4; pl. xii, figs. 2, 3; pl. xiii, figs. 1, 5; pl. xxvi, figs. 1, 3; pl. xxvii, figs. 2, 2*a*, 3.

G. cyclopteroides, var. *subauriculata*, Feistmantel, ibid., p. 13, pl. x, figs. 1, 1*a*, 1*b*; pl. xiii, fig. 2; pl. xv, figs. 1–3; pl. xvi, fig. 3.

G. cyclopteroides, var. *areolata*, Feistmantel, ibid., p. 14, pl. x, fig. 2; pl. xvi, figs. 4, 4*a*.

G. cyclopteroides, var. *attenuata*, Feistmantel, ibid., p. 14, pl. xi, fig. 1; pl. xii, fig. 1; pl. xiii, fig. 3; pl. xiv, figs. 1, 2; pl. xvi, fig. 5; pl. xxvii, figs. 1, 1*a*.

1881. *G. obliqua*, Feistmantel, Rec. Geol. Surv. India, vol. xiv, pt. 3, p. 242, pl. ii, fig. 5 (pars).

G. cyclopteroides, Feistmantel, Flora Gondw. Syst., Suppl., p. 54, pl. xxxi, fig. 2.

G. Hughesi, Feistmantel, ibid., vol. iii, pt. 3, p. 109, pl. xliii A, figs. 6–8.

G. cyclopteroides, Feistmantel, ibid., p. 110.

G. cyclopteroides, var. *subauriculata*, Feistmantel, ibid., p. 111.

G. cyclopteroides, var. *areolata*, Feistmantel, ibid., p. 111.

G. cyclopteroides, var. *attenuata*, Feistmantel, ibid., p. 111.

1882. *G. cyclopteroides*, Feistmantel, ibid., vol. iv, pt. 1, p. 37, pl. xvi, figs. 1–3, 4*a*.

G. cyclopteroides, var. *attenuata*, Feistmantel, ibid., p. 38, pl. xvi, fig. 4*b*

G. cyclopteroides, var. *subauriculata*, Feistmantel, ibid., p. 38, pl. xxi, fig. 1.

1883. *G. obliqua*, Tenison-Woods, Proc. Linn. Soc. New South Wales, vol. viii, p. 127.

G. Clarkeana, Tenison-Woods, ibid., p. 127.

G. spathulata, Tenison-Woods, ibid., p. 127.

1886. *G. obliqua*, Johnston, Papers and Proc. Roy. Soc. Tasmania for 1885, p. 379.

G. spathulata, Johnston, ibid., p. 379.

1886. *Gangamopteris Clarkeana*, Johnston, ibid., p. 380.
G. cyclopteroides, Feistmantel, Flora Gondw. Syst., vol. iv, pt. 2, p. 30, pl. vi A, figs. 1, 2; pl. viii A, fig. 6; pl. ix A, fig. 2; pl. xii A, fig. 17; pl. xiii A, fig. 1; pl. xiv A, figs. 1–4.
G. cyclopteroides, var. *subauriculata*, Feistmantel, ibid., p. 31, pl. v A, fig. 10; pl. vi A, figs. 3, 4; pl. vii A, figs. 1–3, 6; pl. viii A, figs. 2, 3; pl. ix A, figs. 1, 3, 4*b*, 4*c*; pl. x A, figs 1–7; pl. xiii A, figs. 3, 7; pl. xiv A, fig. 5.
G. cyclopteroides, var. *attenuata*, Feistmantel, ibid., p. 32, pl. viii A, fig. 1; pl. ix A, fig. 4*a*; pl. xiii A, figs. 4, 6; pl. xiv A, fig. 6.
G. cyclopteroides, var. *acuminata*, Feistmantel, ibid., p. 32, pl. vii A, figs. 4 (?), 5; pl. viii A, fig. 5; pl. xi A, figs. 4, 7.
G. cyclopteroides, var. *cordifolia*, Feistmantel, ibid., p. 32, pl. xi A, figs. 1, 2, 5; pl. xii A, figs. 16, 18; pl. xiii A, fig. 2.
G. cf. *obliqua*, Feistmantel, ibid., p. 33, pl. xi A, fig. 3.

1888. *G. obliqua*, Johnston, Geol. Tasmania, p. 111, pl. viii, figs. 10–14, 15, 17.
G. spatulata, Johnston, ibid., p. 111, pl. viii, figs. 1, 18; pl. x, figs. 4, 8, 15.
G. Clarkeana, Johnston, ibid., p. 111.

1889. *G. cyclopteroides*, var. *attenuata*, Feistmantel, Abhand. böhm. Gesell. Wiss. Prag, ser. VII, vol. iii, p. 37, pl. iv, fig. 2.

1890. *G. cyclopteroides*, Feistmantel, Mem. Geol. Surv. New South Wales, Pal., No. 3, p. 131.
G. cyclopteroides, var. *attenuata*, Feistmantel, ibid., p. 132.
G. cyclopteroides, var. *subauriculata*, Feistmantel, ibid., p. 132.
G. obliqua, Feistmantel, ibid., p. 132.
G. spathulata, Feistmantel, ibid., p. 133.
G. Clarkeana, Feistmantel, ibid., p. 131, pl. xx, fig. 3.

1893. *G. cyclopteroides*, Oldham, Man. Geol. India, p. 162, pl. opp. p. 158.

1894. *G. cyclopteroides*, Kurtz, Rev. Mus. La Plata, vol. vi, p. 129, pl. ii, figs 1–3.

1895. *G. cyclopteroides*, Zeiller, Bull. Soc. Géol. France, ser. III, vol. xxiii, p. 615, pl. x, figs. 1–3.
G. cyclopteroides, Bodenbender, Rev. Mus. La Plata, vol. vii, table opposite p. 148.

1896. *G. cyclopteroides*, Bodenbender, Zeitsch. deutsch. geol. Gesell., vol. xlviii, table opposite p. 772.

1897. *G. cyclopteroides*, Seward, Quart. Journ. Geol. Soc., vol. liii, p. 323, pl. xxii, fig. 1, and text-fig. 1*c* on p. 324.

1898. *G. cyclopteroides*, Seward, Quart. Journ. Geol. Soc., vol. liv, p. 92.

1900. *G. cyclopteroides*, Zeiller, Élém. Paléobot., p. 115, text-fig. 88.

1901. *G. cyclopteroides*, Amalitzky, Compt. Rend., vol. cxxxii, p. 592.

1903. *G. cyclopteroides*, Seward, Ann. S. African Mus., vol. iv, pt. 1, pp. 79, 82, pl. xiii, fig. 5.

Types. Carruthers', V. 229, Geol. Dept. British Museum (Nat. Hist.); Feistmantel's, ? Mus. Geol. Surv. India, Calcutta.

Frond fairly broad, obovate, broadly elliptical, oval-lanceolate, or almost elongate-lanceolate, symmetrical or asymmetrical. Apex broadly rounded, or obtusely pointed. Frond somewhat contracted towards the base; basal angles sometimes auriculate. Nerves radiating from the base and from a few sub-parallel median nerves, forming meshes, longer and broader in the central portion of the frond, but narrower towards the margin. Sometimes the meshes in the basal portion of the frond are broader and more polygonal than those of the rest of the lamina.

The fronds of this species vary greatly in shape and size, although the nervation is remarkably constant in the different varieties or forms. In some of the broader and more obtuse leaves figured by Feistmantel, the meshes appear to be slightly broader or more open than in certain of the narrower and more pointed leaves, but this distinction does not appear, judging from his figures, always to hold good.

I regard McCoy's[1] *G. obliqua*, and possibly also *G. spatulata*, as identical with the Indian fronds included here under this species. If this be the case, one of his specific names should, strictly speaking, have priority over Feistmantel's *G. cyclopteroides*, but the latter term has become so widely known that I have hesitated to make any change.

The specimen figured by Carruthers as *Noeggerathia obovata* has been regarded by Zeiller[2] as possibly identical with *Euryphyllum Wittianum*. A re-examination of it has, however, shown that, although the preservation is far from good, there can be no doubt as to the evidence that the nerves anastomose with one another, and consequently this plant is a *Gangamopteris*, and may probably be referred to this species (see pp. 111–113).

Several of Feistmantel's species of *Gangamopteris* appear to be indistinguishable from *G. cyclopteroides*. The fragmentary fronds named by him *G. Hughesi*[3] differ only in the meshes of the nervation being somewhat larger than usual, and seem to me to be unworthy of separate specific rank. The very imperfect fragment named *G. anthrophyoides*[4] furnishes quite inadequate evidence on

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[1] McCoy (74). [2] Zeiller (95[1]), p. 963; (95[2]), p. 616, pl. x.

[3] Feistmantel (80), p. 109, pl. xliii A, figs. 6–8.

[4] Feistmantel (80), p. 108, pl. xxxix A, fig. 8; (86), p. 34, pl. v A, fig. 4.

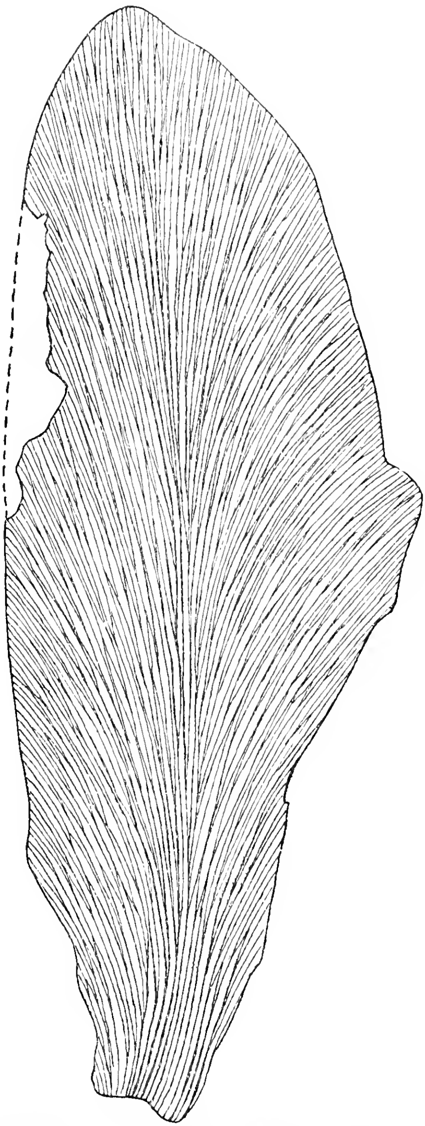

FIG. 26.—*Gangamopteris cyclopteroides*, Feist. After Feistmantel. Nat. size.

which to found a specific diagnosis, and is best described as *Gangamopteris*, sp.

The Australian frond to which Feistmantel gave the name *G. Clarkeana* should perhaps be also included with *G. cyclopteroides*; at any rate, it does not seem to me to be worthy of separate rank. The chief differences appear to be the comparatively small size, the coriaceous texture, and the thicker and more distant nerves. Feistmantel[1] himself noticed the resemblance between this frond and McCoy's *G. spatulata*, here included with *G. cyclopteroides*.

Feistmantel has determined several Indian varieties of this species, most of which appear to me to be hardly worthy of distinction. *G. cyclopteroides*, var. *subauriculata*, includes fronds, very elongately oval or elliptical in habit, in which the basal angles broaden out slightly in an auriculate manner. The nervation is, however, identical with the ordinary form. In *G. cyclopteroides*, var. *areolata*, the meshes in the lower portion of the frond are broader and more polygonal than in the rest of the lamina. *G. cyclopteroides*, var. *attenuata*, is indistinguishable from the typical frond, except in the fact that the leaf is more distinctly narrowed at the base. Similarly his variety *acuminata* includes fronds with an acuminate apex. The leaves distinguished as the variety *cordifolia* appear to be only small fronds of the same type, and in several cases the evidence for the base of the leaf being cordate in shape is hardly trustworthy.

Distribution.—*Permo-Carboniferous* (Glossopteris flora):—India, in the Talchir and Damuda divisions; New South Wales, in the Newcastle Series; Victoria; Tasmania; South Africa, Transvaal; South America, Brazil and Argentina. *Permian* (Northern Type):—Russia.

Fronds of Gangamopteris cyclopteroides from India.

V. 7150. Part of a long, lanceolate frond, of which this is an apical portion, measuring about 11 cm. in length. The nervation is fairly clear. Apparently there is no definite midrib, but a bundle of sub-parallel nerves traverse the median portion of the leaf.

Near Nágpur. *Hunter Coll.*

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[1] Feistmantel (78), p. 93, pl. xv, fig. 9; (90), p. 131, pl. xx, fig. 3.

V. 226*a*. A piece of shale without any record of the locality, but probably derived from India. Several leaves are seen, of which one, measuring 12 cm. long, and rather more than 4 cm. broad at its widest part, is nearly complete. The nervation is, however, badly preserved. Two more imperfect fragments of somewhat smaller fronds also occur, as well as some long, attenuated basal portions.

? India. *Pres. by C. W. Wilmot, Esq.*, 1883.

V. 226*b*. A fairly complete frond in which the nervation is scarcely preserved. A basal portion of a leaf also occurs.

? India. *Pres. by C. W. Wilmot, Esq.*, 1883.

V. 226*c*. A median portion of a leaf, 9 cm. long, in which the nervation can to some extent be seen. Also a fragment of a broader leaf, with apparently similar nervation.

? India. *Pres. by C. W. Wilmot, Esq.*, 1883.

V 226*d*. Fragments of fairly large fronds, and an attenuated basal portion. The nervation is visible here and there.

? India. *Pres. by C. W. Wilmot, Esq.*, 1883.

V. 226*e*. Two incomplete fronds, one an apical, and the other a basal portion. The nervation is to some extent preserved.

? India. *Pres. by C. W. Wilmot, Esq.*, 1883.

Gangamopteris, sp., from India.

V. 226*g* (? India; *presented by C. W. Wilmot, Esq.*, 1883); **V. 7130** (Bharatwada, 9 miles north of Nágpur; *Hunter Coll.*); **V. 7199** (? India); **V. 7200** (Silewáda, 12 miles north of Nágpur; *Hunter Coll.*).

Fronds of Gangamopteris cyclopteroides from New South Wales.

V. 6253. A felted mass of fronds of *Glossopteris*, with which is associated a fragment of a leaf, without a well-marked midrib, but with a median group of sub-parallel veins. These features would suggest reference to the genus *Gangamopteris* rather than *Glossopteris*.

Port Stephens.

V. 2753. Some of these fronds may possibly be referred to this genus and species, but it is difficult to feel confident on this point.

Cullen Bullen, near Mudgee.

Pres. by W. H. Shrubsole, Esq., 1892.

V. 2753*a*. In addition to a frond of *Noeggerathiopsis*, an orbicular frond, 2·4 cm. long and 2·8 cm. across, occurs on this specimen. It appears to have no well-defined midrib, although the median nerves anastomose. It is probably identical with this species.

Cullen Bullen, near Mudgee.

Pres. by W. H. Shrubsole, Esq., 1892.

V. 7213. A piece of grey shale containing a number of fairly perfect fronds of *Glossopteris Browniana*, and a small spathulate frond, 3 cm. long, apparently without a midrib.

Port Stephens.

Fronds of Gangamopteris cyclopteroides from Tasmania.

V. 3776*m*. Pl. III, Fig. 4.

A small oval-spathulate frond, 3 cm. long, and 17 mm. across at its widest point. The apex and base are imperfect. The nervation is well preserved, there being no midrib, but a few sub-parallel, anastomosing median nerves. The lateral veins mostly spring from the median series, and are arched. Other fragments of similar fronds, and of *Glossopteris* occur on the same specimen.

Mersey River. *Pres. by T. Stephens, Esq.*, 1898.

V. 3776*n*. Pl. III, Fig. 5.

A somewhat narrower leaf than the preceding specimen, measuring 3 cm. long, and 15 mm. across. The apex is obtusely pointed. Like the last example this leaf recalls the scale-fronds of *Glossopteris*, from which, however, it differs in being considerably larger, less pointed at the apex, and flat instead of concave. Several other fragments of a similar type occur on the same specimen.

Mersey River. *Pres. by T. Stephens, Esq*., 1898.

V. 3776*s*. An apical portion of a frond apparently without a midrib. A slight median groove is present. The lateral nervation is acute, and the meshes rather narrow.

Mersey River. *Pres. by T. Stephens, Esq.*, 1898.

V. 3776*t*. This specimen shows a mass of fronds, some of which appear to belong to *Gangamopteris*, as they have no definite midrib, but a series of sub-parallel median veins.

Mersey River. *Pres. by T. Stephens, Esq.*, 1898.

V. 3776*u*. A basal portion of a frond, about 2·5 cm. long, showing the median nerves and the lateral meshes. Other and more fragmentary leaves occur, as well as fronds of *Glossopteris*.

Mersey River. *Pres. by T. Stephens, Esq.*, 1898.

V. 3776*p*. One or two leaves without midribs, but with an anastomosing nervation, are found in association with *Glossopteris Browniana* and *Noeggerathiopsis Hislopi*.

Mersey River. *Pres. by T. Stephens, Esq.*, 1898.

Other specimens:—**V. 3776***q*, **V. 3776***r* (Mersey River; *presented by T. Stephens, Esq.*, 1898).

Fronds of Gangamopteris cyclopteroides from the Transvaal.

V. 3621. Figured by Seward (97[1]), p. 323, text-fig. 1*c* on p. 324.

A small lanceolate frond, 4·8 cm. long, without a midrib, showing the nervation fairly well.

Casey's Township, Johannesburg.

Pres. by D. Draper, Esq., 1897.

V. 3615. Figured by Seward (97[1]), p. 323, pl. xxii, fig. 1.

This specimen shows a felted mass of fronds on a piece of iron-stained sandstone. Some of these belong to *Glossopteris*. There is also a broadly oval leaf, 10 cm. long and 6 cm. broad, apparently without a midrib. The nervation is not very well preserved.

Vereeniging. *Pres. by D. Draper, Esq.*, 1897.

V. 8321. Described by Seward (98[2]), pp. 92, 93.

A fragmentary portion of a frond, probably of this species, occurring with *Glossopteris indica*. The nervation is not well preserved, but there is apparently no midrib.

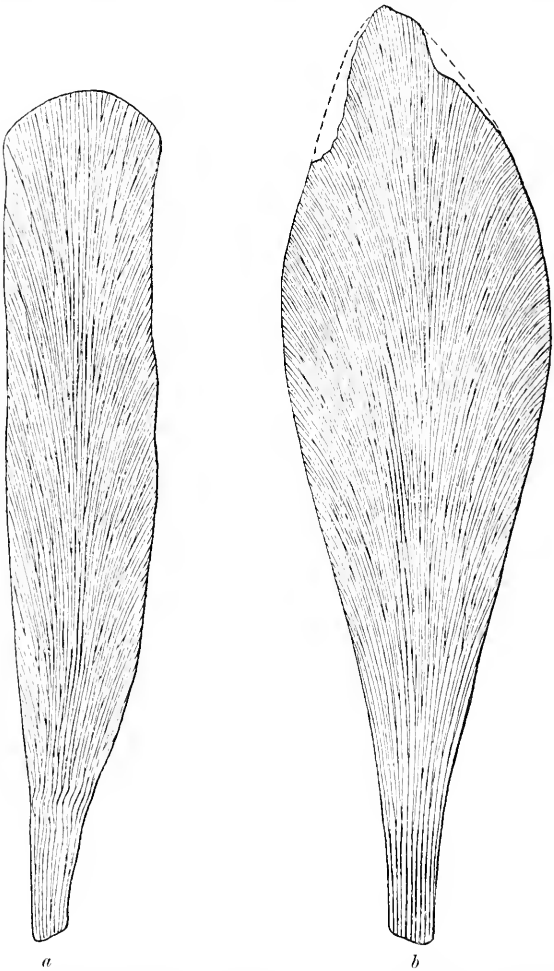
Vereeniging. *Pres. by Dr. F. H. Hatch*, 1898.

Frond of Gangamopteris cyclopteroides from Brazil.

V. 229. Figured by Carruthers (69), pl. vi, fig. 1.

An almost complete, oval-spathulate, obtuse frond, 17 cm. long and 4 cm. across at the widest part. There is no midrib, and the nerves can be seen spreading from the base throughout the lamina, although the details of the nervation are not well preserved. In

the upper portion, the dichotomy and anastomoses of the nerves can be clearly seen. As mentioned above (p. 106), this fossil was



a b

FIG. 27.—(*a*) *Gangamopteris* (?) *buriadica*, Feist. $\frac{3}{4}$ nat. size. (*b*) *Gangamopteris cyclopteroides*, var. *major*, Feist. $\frac{2}{3}$ nat. size. Both after Feistmantel.

described by Carruthers as *Noeggerathia obovata*, but was referred by Zeiller, who, I believe, has not had the advantage of seeing the

specimen, to the genus *Euryphyllum*. It is, however, a true *Gangamopteris*.

Sierra Partida, Candiota, Rio Grande do Sul.

Pres. by N. Plant, Esq., 1869.

2. Gangamopteris cyclopteroides, var. major, Feistmantel.

(Text-fig. 27*b*.)

1879. *Gangamopteris major*, Feistmantel, Flora Gondw. Syst., vol. iii, pt. 1, p. 15, pl. xiv, fig. 3; pl. xvi, figs. 1, 2, 2*a*.
1882. *G. major*, Feistmantel, ibid., vol. iv, pt. 1, p. 38, pl. xv, figs. 13, 14; pl. xx, fig. 2.
1886. *G. major*, Feistmantel, ibid., vol. iv, pt. 2, p. 33, pl. v A, fig. 9; pl. xi A, fig. 9.
1893. *G. major*, Oldham, Man. Geol. India, p. 162, pl. opp. p. 158.
1901. *G. major*, Amalitzky, Compt. Rend., vol. cxxxii, p. 592.

Type. ? Mus. Geol. Surv. India, Calcutta.

Feistmantel has distinguished as *G. major* some spathulate leaves in which the basal portion is longer and narrower than in the commoner examples of this genus, and has comparatively few nerves (Text-fig. 27*b*). These differences appear to me to be hardly sufficient to warrant specific rank; the frond in other respects, especially in its general nervation, being closely similar to the more lanceolate forms of *G. cyclopteroides* (cf. Feistmantel (79[1]), pl. xiv, fig. 1). Feistmantel has compared these leaves with McCoy's *G. spatulata*. This variety is known from the Karharbári and Talchir Series in India, and from the Permian of Russia.

Not represented in the British Museum collection.

3. Gangamopteris angustifolia, McCoy.

1847. *Cyclopteris angustifolia*, McCoy, Ann. & Mag. Nat. Hist., vol. xx, p. 148, pl. ix, figs. 3, 3*a*.
1875. *Gangamopteris angustifolia*, McCoy, Prodr. Palæont. Victoria, dec. II, p. 11, pl. xii, fig. 1; pl. xiii, figs. 2, 2*a*.
1876. *G. angustifolia*, Feistmantel, Rec. Geol. Surv. India, vol. ix, pt. 3, p. 120.
1878. *G. angustifolia*, Feistmantel, Palæontogr., Suppl. iii, pp. 93, 102.
1879. *G. angustifolia*, Feistmantel, Flora Gondw. Syst., vol. iii, pt. 1, p. 16, pl. ix, figs. 5, ? 2.
1881. *G. angustifolia*, Feistmantel, Flora Gondw. Syst., vol. iii, pt. 1, Suppl., p. 55, pl. xxx, fig. 10.

1883. *Gangamopteris angustifolia*, Tenison-Woods, Proc. Linn. Soc. New South Wales, vol. viii, p. 127.
1886. *G. angustifolia*, Feistmantel, Flora Gondw. Syst., vol. iv, pt. 2, p. 33.
G. angustifolia, Johnston, Papers and Proc. R. Soc. Tasmania for 1885, p. 380.
1888. *G. angustifolia*, Johnston, Geol. Tasmania, p. 111, pl. viii, figs. 8, 9, 19.
1890. *G. angustifolia*, Feistmantel, Mem. Geol. Surv. New South Wales, Pal., No. 3, p. 130.
1902. *G. angustifolia*, Arber, Quart. Journ. Geol. Soc., vol. lviii, p. 13.

Type. No. 18, Foreign Plant Coll., Sedgwick Mus., Cambridge.

Frond strictly linear or linear-lanceolate, margins sub-parallel, unsymmetrical, acuminate, sharply contracted at the base, with a well-marked median groove. Nerves anastomosing to form narrow, elongate meshes.

The Cambridge type-specimen is some 9 cm. in length, and slightly more than 2 cm. wide. In shape it is linear, with almost parallel sides, whereas another frond figured by McCoy[1] in 1875 is more lanceolate in contour. There is a broad, shallow, median longitudinal groove. The lateral nerves arise by dichotomy chiefly from a sub-parallel group of median nerves, and form rather close meshes.

Distribution.—Permo-Carboniferous (Glossopteris flora):—India, in the Talchir division; New South Wales, in the Newcastle Series; Victoria, in the Bacchus Marsh Beds; Tasmania, in the Mersey River Series.

? V. 3776 *p.* A small linear-lanceolate leaf, about 3 cm. long, occurs with other fronds on this specimen. It is difficult to decide whether there is a midrib or not, consequently the attribution of this specimen to *Gangamopteris* is somewhat doubtful. If it does belong to this genus, it is probably identical with McCoy's *G. angustifolia.*

Mersey River, Tasmania. *Pres. by T. Stephens, Esq*, 1898.

4. Gangamopteris Whittiana, Feistmantel.

1876. *Gangamopteris Whittiana*, Feistmantel, Journ. Asiat. Soc. Bengal, vol. xlv, pt. 2, p. 371, pl. xx, figs. 3, 4.
1880. *G. Whittiana*, Feistmantel, Flora Gondw. Syst., vol. iii, pts. 2, 3, p. 109, pl. xliii A, figs. 1, 2.

[1] McCoy (75). pl. xii, fig. 1.

Type. No. 5320, Mus. Geol. Surv. India, Calcutta.

Frond broadly ovate or sub-rhomboidal, unsymmetrical. Apex acuminate. Frond with a slight median furrow, but without a midrib. Nervation radiating from the base, forming broad, oblong, hexagonal or polygonal meshes.

These characters are based on two imperfect fronds described by Feistmantel from the Raniganj Group, India, which, if they are correctly assigned to this genus, differ from *G. cyclopteroides* chiefly in the large size of the meshes. *G. Whittiana*, among Gangamopterids, appears to correspond to *Glossopteris conspicua* among Glossopterids, in the breadth of the meshes of the network.

Not represented in the British Museum collection.

5. **Gangamopteris (?) buriadica**, Feistmantel.

(Text-fig. 27*a*, p. 112.)

1879. *Gangamopteris* (?) *buriadica*, Feistmantel, Flora Gondw. Syst., vol. iii, pt. 1, p. 15, pl. xviii, figs. 1, 2, 2*a*.

1881. *G.* (?) *buriadica*, Feistmantel, ibid., vol. iii, pt. 1, Suppl., p. 54, pl. xxx, fig. 4.

1886. *G.* cf. *buriadica*, Feistmantel, ibid., vol. iv, pt. 2, p. 33, pl. viii A, fig. 7.

1893. *G. buriadica*, Oldham, Man. Geol. India, p. 162.

Type. Nos. 5023–4, Mus. Geol. Surv. India, Calcutta.

Feistmantel described this species as follows:—Frond pinnate, leaves lanceolate-spathulate, truncated. Nerves radiating from the attenuated base, somewhat strong, bifurcating, and anastomosing, forming very erect, long, and narrow meshes.

The shape and nervation of this frond, especially the erect course of the nerves, recall some of the leaves included under *Noeggerathiopsis Hislopi* (Bunb.), from which it differs chiefly in the anastomosing nervation. There is no real evidence that these leaves formed portions of a pinnate frond, as Feistmantel has suggested.

G. (?) *buriadica* is known only from the Karharbári Beds of India.

Not represented in the British Museum collection.

Genus **NEUROPTERIDIUM**, Schimper, 1869.

[Traité, vol. i, p. 447.]

Frond simply pinnate, pinnules lobed or entire, usually orbicular, inserted by the whole base or by the lower portion of the base.

Median nerve more or less distinct near the base of the pinnule, dissolving into radiating, frequently dichotomising nerves at some distance from the apex.

Neuropteridium was originally established by Schimper as a subgenus of *Neuropteris* for the reception of some fronds from the Bunter rocks of the Vosges. More recently it has been raised to generic rank as a convenient designation for certain fronds of Permo-Carboniferous and Triassic age, which differ in several important respects, especially in the simply pinnate form of leaf, from the well-known Neuropterids of the Permo-Carboniferous rocks of the Northern Hemisphere.

Little is known with regard to the fructification of any member of the genus. Zeiller[1] has stated that the Triassic fronds, determined by Schimper & Mougeot[2] as *Crematopteris*, may possibly be fertile pinnæ of a *Neuropteridium*. The examples so far available do not, however, offer any definite evidence as to the structure of the sporangia. On the other hand, Seward[3] has recently suggested that the entire absence of fertile leaves, similar in type to *Crematopteris*, in association with *Neuropteridium validum*, the representative of this genus in the Glossopteris flora, points rather to the fact that these fronds may have borne reproductive organs of the Gymnospermous and not of the Filicineau type. The same author has also compared the fronds of this genus with those of *Cardiopteris*, and others from the Carboniferous rocks of Europe.

Distribution.—Permo-Carboniferous (Glossopteris flora):—India, in the Karharbári Beds; Cape Colony, in the Ecca Series; Brazil; Argentina. *Triassic* (Northern Type):—Bunter of the Vosges.

Neuropteridium validum, Feistmantel.

(Pl. VI, Fig. 1; Text-fig. 28.)

1869. *Odontopteris Plantiana*, Carruthers, Geol. Mag., vol. vi, p. 155, pl. vi, figs. 2, 3.

1876. *Neuropteris valida*, Feistmantel, Rec. Geol. Surv. India, vol. ix, pt. 3, p. 75.

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[1] Zeiller (00[1]), p. 109.
[2] Schimper & Mougeot (44), pp. 73, 74, pl. xxxv.
[3] Seward (03[1]), p. 84.

1879. *Neuropteris valida*, Feistmantel, Flora Gondw. Syst., vol. iii, pt. 1, p. 10, pls. ii–vi.
1880. *Neuropteridium validum*, Feistmantel, ibid., vol. iii, pts. 2, 3, p. 84.
1881. *N. validum*, Feistmantel, ibid., vol. iii, pt. 1, Suppl., p. 53.
1893. *Neuropteris valida*, Oldham, Man. Geol. India, pl. opp. p. 158.
1894. *Neuropteridium validum*, Kurtz, Rev. Mus. La Plata, vol. vi, p. 127, pl. i, figs. 1, 2.
1895. *N. validum*, Zeiller, Compt. Rend., vol. cxxi, p. 963.
N. validum, Zeiller, Bull. Soc. Géol. France, ser. III, vol. xxiii, p. 616.
N. validum, Bodenbender, Rev. Mus. La Plata, vol. vii, table opposite p. 148.
1896. *N. validum*, Bodenbender, Zeitschr. deutsch. geol. Gesell., vol. xlviii, table opposite p. 772.
1903. *N. validum*, Seward, Ann. S. African Mus., vol. iv, p. 85, pl. x, figs. 1, 1*a*, 1*b*, 2.

Types. Carruthers', V. 228, Geol. Dept. British Museum (Nat. Hist.); Feistmantel's, Nos. 4982–4993, Mus. Geol. Surv. India, Calcutta.

"Frond long and linear, pinnate, rachis strong, bearing pinnules which in the lower part of the frond are entire and more or less semicircular in form, and gradually pass into longer and lobed segments as we ascend the rachis. The longer pinnules, which may reach a length of 6 cm. or more, are not attached by the whole of the base, like the stouter and broader segments in the basal portion of the frond, but the basal lobe of the upper edge of the segment is free from the rachis. Apex of pinnules bluntly rounded. Veins spreading, curving towards the edge of the pinnules with repeated dichotomous branching, and converging in the longer segments to form a fairly distinct midrib in the lower part of the lamina" (Seward (03[1]), p. 86).

The distribution of this frond in the rocks of Gondwanaland is especially interesting. The same species occurs in the Talchir-Karharbári Series of the Lower Gondwanas of India, in Permo-Carboniferous beds in Rio Grande do Sul, Brazil, and in Argentina, and also, as has been shown recently by Mr. Seward, in the Ecca Series of Cape Colony. It is therefore an important and widely distributed type in association with members of the Glossopteris flora. It may be also pointed out that this species agrees very closely, as both Feistmantel and Seward have already demonstrated, with Schimper & Mougeot's[1] *N. grandifolium* from the Triassic rocks of the Vosges.

[1] Schimper & Mougeot (44), p. 77, pl. xxxvi, fig. 1.

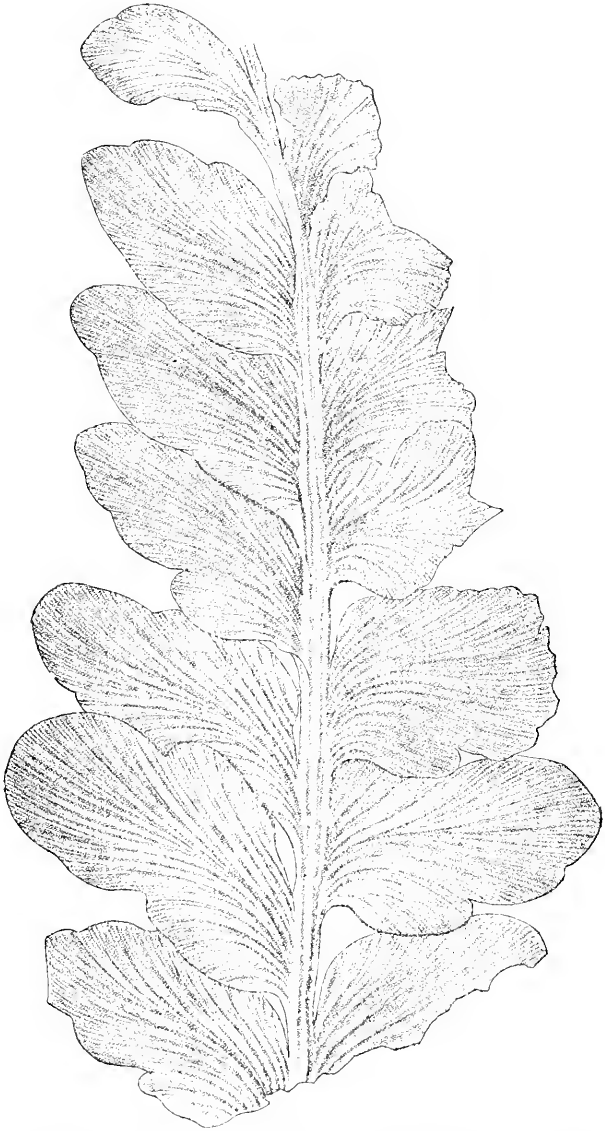

FIG. 28.—*Neuropteridium validum*, Feist. After Feistmantel. Nat. size.

It may be added that a species described by Johnston[1] from Hobart, Tasmania, in 1887, as *Neuropteris tasmaniensis*, Johnst., is stated by that author to be "near to *N. valida*, Feist." No figures of this species are, however, published, and the age of the beds is not very clear.

Although the fronds described by Carruthers as *Odontopteris Plantiana* are now known to belong to this genus and species, and are the earliest described examples, I have maintained Feistmantel's specific name here, since any change would tend to create great confusion. Zeiller[2] was the first to point out the identity of these fossils.

Fronds of Neuropteridium validum from India.

V. 227. Pl. VI, Fig. 1.

A basal portion of a frond showing a number of oval or orbicular pinnules, rounded at the apex, on either side of a rachis. The pinnules at the base of the frond are very small, entire, almost semicircular, and are attached by the whole base. The larger, oval pinnules are somewhat lobed, and the upper portion of the base is free from the rachis. The nervation is fairly clear, the nerves radiating from the base with frequent dichotomy. Other and smaller fragments of fronds occur besides that figured.

? India. *Pres. by C. W. Wilmot, Esq.*, 1883.

V. 227*a*. A small fragment showing the rachis, and three nearly perfect pinnules, in which nervation is very clear. There is no record of the locality with either of these specimens, but there is little doubt that they were derived from India.

? India. *Pres. by C. W. Wilmot, Esq.*, 1883.

Fronds of Neuropteridium validum from Brazil.

V. 228*a*. Figured by Carruthers (69), pl. vi, fig. 2.

A portion of a frond showing lobed pinnules on one side of the rachis. The nervation is fairly clear, the nerves being fine, close, and dichotomising. The impression of the impersistent median nerve can just be made out at the base of the pinnules.

Rio Grande do Sul, Brazil. *Pres. by N. Plant, Esq.*, 1869.

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[1] Johnston (87^2), p. 171.

[2] Zeiller (95^1), p. 963; (95^2), p. 616.

V. 228. Figured by Carruthers (69), pl. vi, fig. 3.

Possibly a large lobed pinnule, but the specimen is not well preserved.

Rio Grande do Sul, Brazil. *Pres. by N. Plant, Esq.*, 1869.

V. 228*b*. A very imperfect example of a pinnule.

Rio Grande do Sul, Brazil. *Pres. by N. Plant, Esq*, 1869.

Genus **TÆNIOPTERIS**, Brongniart, 1828.

[Prodr. Hist. Végét. foss., p. 61.]

Fronds or leaves simple, or more rarely pinnate, ribbon-like, lanceolate, linear-lanceolate, oblong or elliptical, usually entire. Apex acute, acuminate, or obtuse. Median nerve well marked, extending almost to the apex. Lateral nerves arising from the midrib at a very wide angle, numerous, simple or dichotomising once or several times.

A satisfactory definition of this genus is exceedingly difficult if only on account of the transitions which some of these fronds seem to present to those of other genera such as *Nilssonia*. Brongniart's original definition was as follows :—

"Fronde simple, entière, étroite, à bords parallèles, traversée par une nervure moyenne, forte, épaisse, qui s'étend jusqu'à l'extrémité ; nervures secondaires presque simples ou bifurquées à la base, presque perpendiculaires sur la nervure moyenne."

In 1869, Schimper[1] proposed a more extended classification of fronds of this type, restricting the genus *Tæniopteris* to certain species of Palæozoic age, and at the same time instituting a number of other generic names, of which *Macrotæniopteris*, *Oleandridium*, *Angiopteridium*, and *Danæopsis* were the chief.

In more recent times this classification has been criticised on the grounds that there is not sufficient evidence to warrant such separation, and that for the present it is safer and more convenient to group these fronds under the original genus *Tæniopteris*, using that name in a wide sense. This view has been adopted by Nathorst,[2] White,[3] Seward,[4] Zeiller,[5] and others, and is maintained here.

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[1] Schimper (69), vol. i, p. 600, etc.
[2] Nathorst (78).
[3] White (93).
[4] Seward (94), p. 124.
[5] Zeiller (82^2) and (02^3), p. 59.

Tæniopteris is essentially a Mesozoic type of frond in that the genus reaches its maximum development in Triassic and Jurassic times, and extends to the Lower Cretaceous period. It makes its first appearance, however, in the higher horizons of the Upper Carboniferous, and in the Permian rocks of Europe and elsewhere in the Northern Hemisphere, as well as in the Permo-Carboniferous beds of India, ? Australasia, and South Africa.

So far we have no knowledge of the fructification of any of the Palæozoic fronds. Zeiller[1] has, however, recently described the fructification of a certain Triassic species, which presents characters closely identical with those of recent members of the *Marattiaceæ*. It is possible, however, that other fronds included in this genus, in the wide sense adopted here, may eventually prove to be more closely related to the Cycadean stock than to the true Ferns.

1. Tæniopteris danæoides (Royle).

(Pl. V, Fig. 1.)

1833. *Glossopteris danæoides*, Royle, Illust. Bot. Himal. Mounts., p. xxix*, pl. ii, fig. 9.
1836. *Aspidites danæoides*, Göppert, Die Foss. Farn., p. 352.
1850. *Tæniopteris danæoides*, M'Clelland, Rep. Geol. Surv. India, p. 56, pl. xv, figs. 1, 1*a*, 1*b*.
Pecopteris danæoides, Unger, Gen. et Spec. Plant. foss., p. 170.
1876. *Tæniopteris danæoides*, Feistmantel, Rec. Geol. Surv. India, vol. ix, pt. 3, p. 74.
Macrotæniopteris danæoides, Feistmantel, ibid., vol. ix, pt. 4, p. 137.
M. danæoides, Feistmantel, Journ. Asiat. Soc. Bengal, vol. xlv, pt. 2, p. 365, pl. xix, figs. 1, 1*a*, 2; pl. xxi, fig. 1.
1880. *M. danæoides*, Feistmantel, Flora Gondw. Syst., vol. iii, pts. 2, 3, p. 88, pl. xx A; pl. xxi A, figs. 1, 2.
1886. *M. danæoides*, Feistmantel, ibid., vol. iv, pt. 2, p. 24, pl. iv A, figs. 2, 3.
1893. *M. danæoides*, Oldham, Man. Geol. India, 2nd pl. opp. p. 162.
1901. *M. danæoides*, Arber, Geol. Mag., dec. iv, vol. viii, p. 548.

Type. V. 4191, Geol. Dept. British Museum (Nat. Hist.).

Frond large, elliptical or oblong, petiolate, membranous or sub-coriaceous. Midrib thick. Lateral nerves arising at an acute angle, and almost immediately bending towards the margin in

[1] Zeiller (02^3), p. 63.

a direction nearly at right angles to the midrib. Nerves numerous, somewhat distant, strong, dichotomising once, or more rarely twice.

The broad form of the frond, and the somewhat distant and coarse lateral nerves, form the chief characteristics of this species. The veins are at least 1 mm. apart.

This frond was originally referred to the genus *Glossopteris* by Royle, but M'Clelland, in 1850, transferred it to *Tæniopteris*. More recently, several authors, including Feistmantel, have adopted Schimper's generic name *Macrotæniopteris* for this species, which, as has been already pointed out, is a term of doubtful value. The chief characters distinguishing *Macrotæniopteris* from *Tæniopteris* appear to be the larger size of the frond—a point of but little importance—and the more distant secondary nerves.[1]

There is also an obscure fragment, the only specimen of its kind known from the Damuda Series, which was originally described by M'Clelland[2] as *Zamia burdwanensis*. This specimen, preserved in the Calcutta Museum (No. 5340), was refigured by Feistmantel[3] as *Pterophyllum burdwanense*. It would appear doubtful if this is really a Cycadean frond. So far as one can judge from Feistmantel's drawing, it would seem more probable that it may be after all only a torn fragment of a frond of *Tæniopteris*, a conclusion supported by the irregular margin of the supposed pinnules, as shown in the drawing referred to above.

Tæniopteris danæoides occurs in the Raniganj and Barakar Series of the Damuda division in India.

V. 4191. Pl. V, Fig. 1; also figured by Royle (33), pl. ii, fig. 9. *Type.*

A fine specimen of a nearly complete oval-lanceolate frond, the apex being wanting. It measures 13 cm. in length, and 6 cm. across at the widest part. The midrib is stout, and the veins, which are very clear, arise almost at right angles to the midrib, remaining simple or branching dichotomously. There is no regular alternation between the simple or branched veins.

Bardwán Coalfield, India.

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[1] Arber (01), p. 548.
[2] M'Clelland (50), p. 53, pl. xiv, fig. 4.
[3] Feistmantel (80), p. 116, pl. xlviiA, fig. 1.

2. Tæniopteris Feddeni (Feistmantel).

(Text-fig. 29.)

1876. *Macrotæniopteris Feddeni*, Feistmantel, Rec. Geol. Surv. India, vol. ix, pt. 4, p. 137.

M. Feddeni, Feistmantel, Journ. Asiat. Soc. Bengal, vol. xlv, pt. 2, p. 367.

1880. *M. Feddeni*, Feistmantel, Flora Gondw. Syst., vol. iii, pts. 2, 3, p. 89, pl. xxiA, fig. 3; pl. xxiiA, figs. 1–4.

1881. *M. Feddeni*, Feistmantel, Rec. Geol. Surv. India, vol. xiv, pt. 3, p. 255, pl. ii, fig. 1.

1882. *M. Feddeni*, Feistmantel, Flora Gondw. Syst., vol. iv, pt. 1, p. 31, pl. xxi, fig. 5.

1886. *M. Feddeni*, Feistmantel, ibid., pt. 2, p. 24, pl. iA, fig. 1.

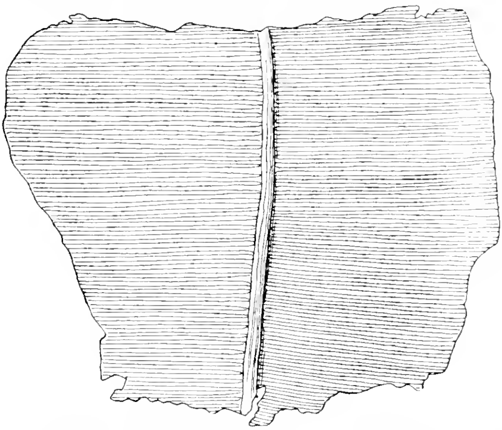

FIG. 29.—*Tæniopteris Feddeni* (Feist.). After Feistmantel. Nat. size.

Type. Nos. 5200, 5203–6, Mus. Geol. Surv. India, Calcutta.

Frond simple, large, elongately elliptical. Apex obtuse or emarginate. Midrib fairly stout, striated. Lateral nerves very numerous, simple or dichotomising close to the midrib, closely approximated, pursuing an almost horizontal direction in the basal portion of the frond, but at a more acute angle to the midrib towards the apex. The nerves at the margin appear to be slightly curved upwards.

T. Feddeni is chiefly distinguished from *T. danæoides* by the closer lateral nervation, and by the thinner midrib. Some of the

fronds figured by Feistmantel are more than 25 cm. long, and 12·5 cm. broad.

T. Feddeni occurs in the Raniganj and Barakar Series of the Damuda division in India.

Not represented in the British Museum collection.

3. Tæniopteris spathulata, M'Clelland.

1850. ? *Tæniopteris spathulata*, M'Clelland, Rep. Geol. Surv. India, p. 53, pl. xvi, fig. 1.
1861. *T. Daintreei*, McCoy, Trans. R. Soc. Victoria, vol. v, pp. 96–107, 215–217.
T. Daintreei, Clarke, ibid., pp. 89–95, 209–214.
1863. *Stangerites spathulata*, Oldham & Morris, Flora Gondw. Syst., vol. i, pt. 2, p. 34, pl. vi, figs. 1–7.
1867. *Tæniopteris Daintreei*, McCoy, Ann. & Mag. Nat. Hist., ser. III, vol. xx, p. 196.
1869. *Angiopteridium spathulatum*, Schimper, Traité, vol. i, p. 605.
1872. *Tæniopteris Daintreei*, McCoy, Rep. Westernport Coalfields, p. 6.
1874. *T. Daintreei*, McCoy, in Smyth's 1st Prog. Rep. Geol. Surv. Victoria, p. 35.
1875. *T. Daintreei*, McCoy, Prodr. Palæont. Victoria, dec. II, p. 15, pl. xiv, figs. 1, 2.
1876. *T. Daintreei*, Feistmantel, Rec. Geol. Surv. India, vol. ix, pt. 4, pp. 122–4.
T. (*Angiopteridium*) *McClellandi*, Feistmantel, ibid., vol. ix, pt. 2, p. 36.
1877. *Angiopteridium spathulatum*, Feistmantel, Flora Gondw. Syst., vol. i, pt. 3, p. 172, pl. i, figs. 6*a*, 7*b*.
1878. *Tæniopteris Daintreei*, Feistmantel, Palæontogr., Suppl. iii, p. 110, pl. xiv, figs. 2, 3; p. 169, pl. xii, figs. 5, 5*a*.
T. Daintreei, Etheridge, jun., Cat. Australian Fossils, p. 100.
1879. *Angiopteridium spathulatum*, Feistmantel, Flora Gondw. Syst., vol. i, pt. 4, p. 206, pl. i, figs. 8–13, 17, 18; pl. ii, figs. 3, ? 5, ? 6; pl. xv, fig. 11.
1882. *Tæniopteris spathulata*, Zeiller, Ann. Mines for 1882 (ii), p. 304, pl. x, fig. 8.
1883. *T. Daintreei*, Tenison-Woods, Proc. Linn. Soc. New South Wales, vol. viii, p. 117.
1886. *T. Daintreei*, Johnston, Papers & Proc. R. Soc. Tasmania for 1885, p. 375.
1890. *T. Daintreei*, Feistmantel, Mem. Geol. Surv. New South Wales, Pal., No. 3, p. 114, pl. xxvii, figs. 4, 5; pl. xxviii, figs. 6, 6*a*.
1892. *T. Daintreei*, Etheridge, jun., Ann. Rep. Dept. Mines New South Wales for 1891, p. 269.
T. (*Angiopteridium*) *Daintreei*, Jack & Etheridge, Geol. & Pal. Queensland, p. 371.

1893. *Tæniopteris spatulata*, Oldham, Man. Geol. India, pl. opp. p. 176.
1898. *Angiopteridium spathulatum*, Dun, Rep. Austr. Assoc. Adv. Sci., p. 390.
1901. *A. spathulatum*, Etheridge, jun., in Anderson, 1st Rep. Geol. Surv. Natal, p. 72.
1902. *Tæniopteris spathulata*, Zeiller, Flore Foss. Gîtes Charb. Tonkin, p. 74, pl. xiii, figs. 6–12.

Type. M'Clelland's, ? Mus. Geol. Soc. India, Calcutta; McCoy's (*T. Daintreei*), ? Melbourne Museum, Victoria.

Fronds simple, with parallel sides, entire, strictly linear-lanceolate or linear-spathulate, gradually contracted towards the base, petiole short or almost absent, apex spathulate, rounded or obtusely pointed. Leaves 3–12 mm. broad, 6–15 cm. long. Rachis between ·5 and 1 5 mm. broad, smooth or longitudinally striated, or with fine transverse flutings. Nerves very spreading, generally bifurcating at the base, to the number of 25–30 per centimetre at the margin. Lamina often marked by more or less pronounced transverse folds, dividing it up into compartments which are clearly convex, $\frac{1}{3}$–$\frac{2}{3}$ mm. in height, each traversed by a bifurcating nerve.

Zeiller[1] has recently given a full diagnosis of this species, of which the above is a translation, but which applies only to the Indian species *T. spathulata*. In 1892, however, Etheridge[2] expressed the opinion that McCoy's *T. Daintreei*, a type of frond from Australasia, is identical with *T. spathulata*, and Dun[3] in his revision of the Australian Tæniopterids has adopted this conclusion.

The full specific diagnosis given by Etheridge agrees very well, in its main essentials, with that of Zeiller. The chief characteristics of this species are the very long, narrow, strap-shaped leaves, the thick midrib of nearly equal size throughout the length of the frond, and the lateral nervation, composed of veins distant or close, simple or bifurcating.

On the other hand, the specimens described by Carruthers[4] as *T. Daintreei*, from the Tivoli coal-mines of Ipswich, Queensland, belong to a separate species, for which Tenison-Woods[5] instituted

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[1] Zeiller (02³), pp. 74, 75.
[2] Jack & Etheridge (92), p. 373.
[3] Dun (98), p. 390.
[4] Carruthers (72), p. 355, pl. xxvii, fig. 6.
[5] Tenison-Woods (83), p. 117; see also Feistmantel (90), p. 115; Seward (03¹), p. 59.

the name *T. Carruthersi.* Both the species recorded by Feistmantel[1] from the Cape Colony are also identical with *T. Carruthersi.*

This species is probably more characteristic of the Mesozoic than of the Palæozoic rocks. It, however, occurs in Natal, where it has recently been recorded by Etheridge in association with the Glossopteris flora.

Distribution.—Permo-Carboniferous (Glossopteris flora):—Natal. *Triassic, Rhætic,* or *Jurassic*:—India (Upper Gondwanas), Tonquin, New South Wales, Victoria, Queensland, and Tasmania.

Not represented in the British Museum collection from the Palæozoic rocks.

4. Tæniopteris cf. M'Clellandi (Oldham & Morris).

1850. ? *Tæniopteris acuminata,* M'Clelland, Rep. Geol. Surv. India, p. 53, pl. xvi, fig. 2.
1861. ? *T. danæoides* (?), Bunbury, Quart. Journ. Geol. Soc., vol. xvii, p. 332, pl. x, fig. 2.
1863. *Stangerites McClellandi,* Oldham & Morris, Flora Gondw. Syst., vol. i, pt. 1, p. 33, pl. xxiii.
1869. *Angiopteridium MacClellandi,* Schimper, Traité, vol. i, p. 605.
1877. *A. MacClellandi,* Feistmantel, Flora Gondw. Syst., vol. i, pt. 2, p. 96, pl. xlvi, figs. 5, 6.
1879. *A. MacClellandi,* Feistmantel, ibid., vol. i, pt. 4, p. 207, pl. i, figs. 14–16; pl. ii, fig. 4.
1880. *A.* cf. *Mc'Clellandi,* Feistmantel, ibid., vol. iii, pts. 2, 3, p. 92, pl. xxiA, figs. 4–7.
1882. *A.* cf. *mcClellandi,* Feistmantel, ibid., vol. iv, pt. 1, p. 31.
Tæniopteris MacClellandi, Zeiller, Ann. Mines for 1882 (ii), p. 302, pl. x, fig. 5.
1902. *T. MacClellandi,* Zeiller, Flore Foss. Gîtes Charb. Tonkin, p. 61, pl. ix, figs. 3–5.

Type. ? Mus. Geol. Surv. India, Calcutta.

Pinnæ (? fronds) entire, with parallel sides, clearly contracted towards the base, ending at the apex in a rounded point. Pinnæ 25–55 mm. broad. Rachis 1–3 mm. broad, longitudinally striated. Lateral nerves spreading, clearly decurrent at the base, bifurcating to form two simple or dichotomising nerves, either at their point of origin, or at some little distance from the midrib, clearly arched

[1] Feistmantel (89), p. 65, pl. ii, figs. 6–11.

forwards towards their extremity; at the margin from 20 to 30 in number per centimetre of length.[1]

This species is still imperfectly known. It would appear to be essentially a Mesozoic type of frond, but some leaves associated with the Glossopteris flora in India may be compared with those occurring in the Rajmahal Series (Jurassic) of India.

Of these, the earliest described was probably the frond which M'Clelland[2] figured as *T. acuminata* in 1850. His description and figure are, however, too imperfect to feel any confidence as to the identity of the specimen with Oldham & Morris' species. The *Tæniopteris* figured by Bunbury[3] in 1861 (No. R. 10,367 in the Mus. Geol. Soc. London) is probably identical with Feistmantel's Lower Gondwana specimens from the Raniganj Group. They are linear, fairly narrow leaves, the lateral veins being simple, or more often dichotomised close to the point of origin with the midrib. The nerves are not very crowded. They are small imperfect fragments from Kamthi in the Nágpur district, and are no doubt identical with some specimens in the British Museum described here from the same locality.

While admitting that the fronds under discussion show considerable resemblance to the Mesozoic frond *Tæniopteris M'Clellandi* (Oldham & Morris), it does not seem possible to me to correlate them with this species with any confidence, partly on account of the fragmentary nature of specimens so far discovered, and partly because of the great difference in the age of the two deposits. Until better examples have been obtained, they may be referred to provisionally as *Tæniopteris* cf. *M'Clellandi*.

Feistmantel[4] has also distinguished, under the name *Angiopteridium infarctum*, some fronds which recall Bunbury's specimens in size and nervation. They differ, however, in the veins being very approximate, and passing out from the midrib at a more acute angle. Both Feistmantel's figures are of apical portions, and this may in part account for the acuteness of the lateral nerves, which in fronds of this type are often less oblique towards the apex.

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[1] See Zeiller (02^3), pp. 61, 62.
[2] M'Clelland (50), p. 53, pl. xvi, fig. 2.
[3] Bunbury (61), p. 332, pl. x, fig. 2.
[4] Feistmantel (80), p. 93, pl. xxxiv A, figs. 4, 5, 5*a*.

This frond, however, appears to me to be hardly worthy of specific distinction.

Distribution.—*Tæniopteris M'Clellandi* occurs in the Rajmahal Series (Jurassic) of the Upper Gondwanas in India, and in beds of Rhætic age in Tonquin. Fronds somewhat similar to those of the Mesozoic species occur in the Raniganj Group of the Damuda division in the Nágpur district, and in the South Rewah Basin in India.

V. 7133. Small fragments of a *Tæniopteris* of a rather narrow type. The lateral nerves are fine, and fairly distant from each other. These specimens may be compared with *T. M'Clellandi*, especially with the figures given by Feistmantel (80), pl. xxi A, figs. 4–7, of the species. The veins do not appear to branch quite so close to the midrib as in *T. danæoides*.

Kamthi, India. *Hunter Coll.*

V. 7132. A very fragmentary portion of a frond, showing only the midrib and a few indistinct nerves on one side. This specimen is probably of the same nature as the last.

Kamthi, India. *Hunter Coll.*

5. **Tæniopteris,** sp. (from Victoria).

1898. *Tæniopteris Sweeti*, McCoy, Proc. Roy. Soc. Victoria, N.S., vol. x, pt. 2, p. 285, and text-figure.

Type. National Museum, Melbourne.

McCoy, a few years ago, recorded the first *Tæniopteris* of Permo-Carboniferous age known from Australia, which he named *T. Sweeti*. Judging, however, from his text-figure, the specimen is too fragmentary to permit of an accurate specific diagnosis, and I prefer to term it *Tæniopteris*, sp., for the present. This genus occurs rarely with *Gangamopteris* in the Bacchus Marsh Sandstones of Victoria.

Not represented in the British Museum collection.

Genus **PALÆOVITTARIA,** Feistmantel, 1876.

[Journ. Asiat. Soc. Bengal, vol. xlv, pt. 2, p. 368.]

Fronds simple, entire, oval-lanceolate or oval-spathulate, contracted towards the base. Midrib only present in the basal portion

of the frond. Secondary nerves numerous, arising at a very acute angle from the midrib, simple or dichotomising.

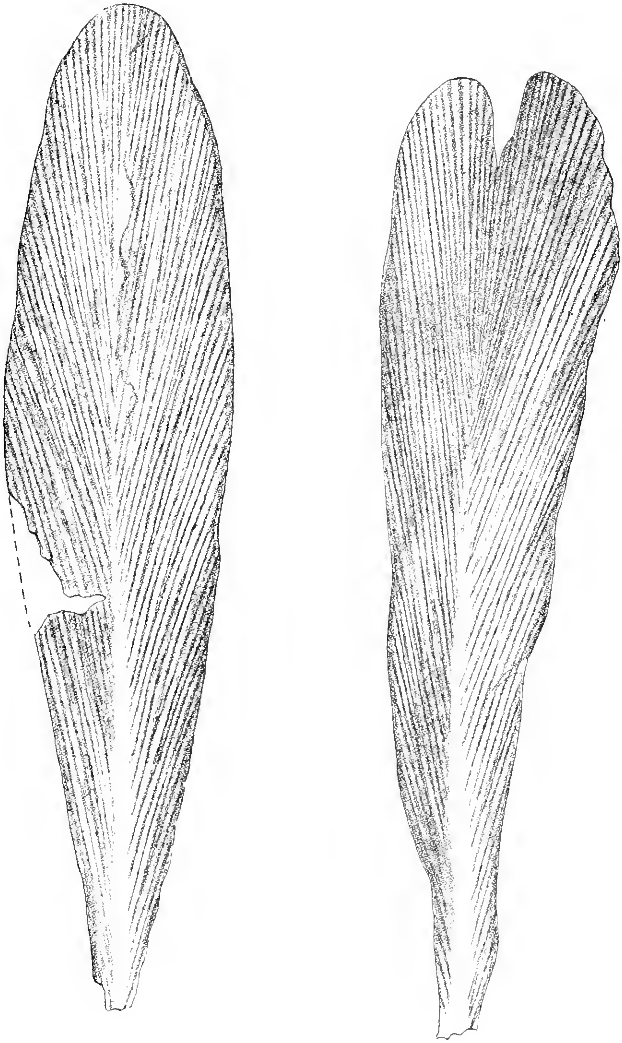

Fig. 30.—*Palæovittaria Kurzi*, Feist. After Feistmantel. Nat. size.

A single species only has been ascribed, I believe, to this genus, occurring in India, and also in the Rhætic beds of Tonquin. A description of the latter specimens has been recently published by Zeiller,[1] and the present account is largely based on his extended diagnosis.

Palæovittaria Kurzi, Feistmantel.

(Text-fig. 30.)

1876. *Palæovittaria Kurzi*, Feistmantel, Journ. Asiat. Soc. Bengal, vol. xlv, pt. 2, p. 368, pl. xix, figs. 3, 3*a*, 4, 4*a*.
1880. *P. Kurzi*, Feistmantel, Flora Gondw. Syst., vol. iii, pts. 2, 3, p. 91, pl. xliv A.
1890. *P.* sp., Schimper, in Zittel, Handb. Palæont., pt. 2, p. 133.
1902. *P. Kurzi*, Zeiller, Flore Foss. Gites Charb. Tonkin, p. 81, pl. xvi, fig. 1.

Type. Nos. 5325–6, Mus. Geol. Surv. India, Calcutta.

Frond oval lanceolate or oval-spathulate, 12–15 cm. long, and 2·5–4·5 cm. broad, rounded at the apex. Median nerve scarcely visible, except in the basal portion of the frond, but indicated by a median fold. Lateral nerves very erect, spreading, a little incurved at the margin, simple or dichotomising once or twice, to the number of eight or ten in a centimetre of length.

The fine specimen figured by Feistmantel shows nine very perfect fronds arranged as if springing from a common point of attachment. Nothing, however, is known of the mode of attachment, nor of the stem which bore these fronds. The fructification is also unknown.

This species is recorded from the Raniganj Group of the Damuda division in India, and occurs in rocks of Triassic age in Tonquin.

Not represented in the British Museum collection.

Genus **SPHENOPTERIS**, Brongniart, 1822.

[Mém. Mus. d'Hist. Nat., vol. viii, p. 233.]

Compound fronds, bi-, tri-, or quadripinnate, deeply or finely divided. Pinnules usually small or, more rarely, of medium size, as a rule more or less deeply divided, lobed, or dentate, rarely entire, contracted at the base. Median nerve of each pinnule

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[1] Zeiller (02³), p. 81.

usually giving off simple or bifurcating nervules to each segment, lobe, or tooth.

Sphenopteris is one of the largest, and at the same time most unsatisfactory, of form-genera. In it are placed fern-like fronds of deeply cut or lobed habit, belonging to rocks of many different ages, and presenting no evidence with regard to the fructification. Consequently their true systematic position is unknown. This type of frond occurs not only in the Palæozoic, Mesozoic, and Tertiary periods, but can be matched among several genera of recent ferns.

1. Sphenopteris polymorpha, Feistmantel.

(Text-fig. 31.)

1850. ? *Pecopteris affinis*, M'Clelland, Rep. Geol. Surv. India, p. 56, pl. xiii, figs. 11, 11*a*, 11*b*.

1861. *Pecopteris* (?), Bunbury, Quart. Journ. Geol. Soc., vol. xvii, p. 331, pl. ix, figs. 6–8.

? *Cladophlebis*, Bunbury, ibid., p. 332, pl. x, fig. 1.

1876. *Sphenopteris polymorpha*, Feistmantel, Journ. Asiat. Soc. Bengal, vol. xlv, pt. 2, p. 356, pl. xvi, figs. 5–7; pl. xvii, figs. 1–3.

1880. *S. polymorpha*, Feistmantel, Flora Gondw. Syst., vol. iii, pts. 2, 3, pp. 76, 77, pls. XVA, XVIA, fig. 3; pl. XVIA *bis*, figs. 1–6.

? *Cyathea* cf. *Tchihatcheffi*, Feistmantel, ibid., p. 75, pl. XVIA, figs. 1, 2, 4.

1882. *Sphenopteris polymorpha*, Feistmantel, ibid., vol. iv, pt. 1, p. 28.

1886. ? *Cyathea* cf. *Tchihatcheffi*, Feistmantel, ibid., vol. iv, pt. 2, p. 23.

1893. *Sphenopteris polymorpha*, Oldham, Man. Geol. India, pl. opp. p. 162.

1902. *S. polymorpha*, Arber, Quart. Journ. Geol. Soc., vol. lviii, p. 12, pl. i, figs. 4, 5.

S. polymorpha, Arber, Geol. Mag., dec. IV, vol. ix, p. 348.

Types. M'Clelland's and Feistmantel's in (?) Mus. Geol. Surv. India, Calcutta.

Frond tripinnate. Rachis broadly winged. Primary pinnæ alternate, or sub-opposite, springing from the primary axis at a wide angle, greatly varied in shape, pinnate in the upper portion of the frond, with slightly sinuate or lobed pinnules; median pinnæ longer, also pinnate, with more deeply incised pinnules; lower pinnæ distinctly bipinnate, with denticulate pinnules. Secondary pinnæ alternate or sub-opposite. Primary nerve of the ultimate pinnæ giving off bifurcating nervules to the lobes of the pinnules.

In some respects *S. polymorpha* recalls *S. lobifolia* and *S. alata* (see pp. 135, 138), but in the form of the terminal segment or pinnule, and in the regularly bifurcating secondary nervation, it does not agree with either of the Australian species.

I have shown recently that this species occurs in the Newcastle Series of New South Wales. Specimens from this locality are in the Sedgwick Museum, Cambridge.

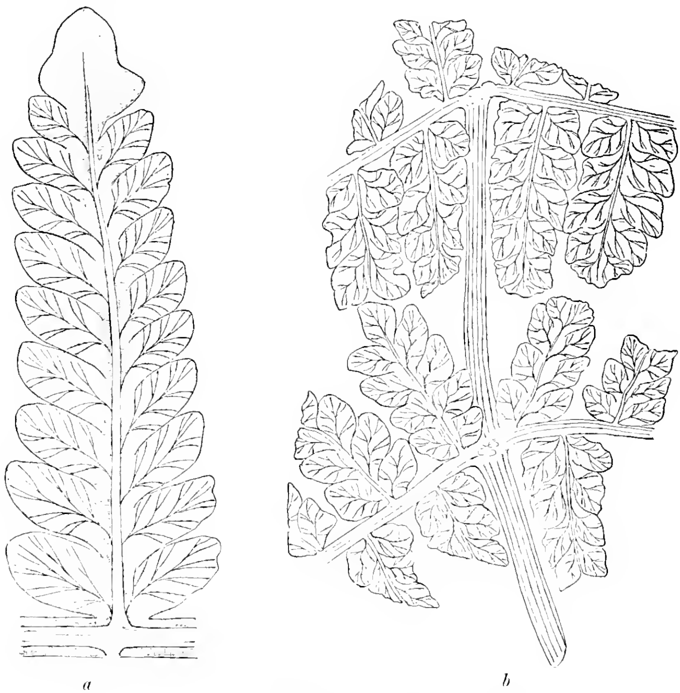

FIG. 31.—*Sphenopteris polymorpha*, Feist. After Feistmantel. *a*, × 2; *b*, nat. size.

I regard M'Clelland's *Pecopteris affinis*, so far as one can judge from his imperfect figure, to be probably identical with *S. polymorpha*, a view which Feistmantel[1] at one time shared, although at

[1] Feistmantel (80), p. 77.

a later period he concluded that they were on the whole distinct. It would, however, be impossible to adopt M'Clelland's specific name, since, though his plant is undoubtedly a *Sphenopteris*, the name *Sphenopteris affinis* had been applied earlier to a Lower Carboniferous frond by Lindley & Hutton.

Feistmantel[1] has also figured under the name *Cyathea* cf. *Tchihatcheffi*, Schmal., some fronds from the Talchir Coalfield, which he originally included with *Sphenopteris polymorpha*. The characters of these leaves are not described, nor is the nervation very clear from his figures. It is therefore difficult to decide how far they differ from the latter species, to which in some cases (cf. Feistmantel (80), pl. xvi A *bis*, fig. 1) they bear a close resemblance. For the present they may, perhaps, be best regarded as one of the varieties of the fronds included here under this specific name. It may be also pointed out that Schmalhausen's species is now known in all probability to be identical with *Pecopteris leptophylla*, Bunbury, from the Lower Permian of Portugal.[2]

Sphenopteris polymorpha is known from the Barakar and Raniganj Groups of the Damuda division in India, and from the Newcastle Series in New South Wales.

Not represented in the British Museum collection.

2. Sphenopteris Hughesi (Feistmantel).

(Text-fig. 32.)

1877. *Dicksonia* cf. *concinna*, Feistmantel, Rec. Geol. Surv. India, vol. x, pt. 4, p. 198, figs. 10, 11 of plate.

1881. *D. Hughesi*, Feistmantel, Flora Gondw. Syst., vol. iii, pts. 2, 3, p. 78, pl. xxiii A, figs. 1, 3, 12, 12*a*, 13.

1882. *D. Hughesi*, Feistmantel, ibid., vol. iv, pt. 1, p. 28, pl. xii, figs. 3, 3*a*, 3*b*.

1902. *Sphenopteris* (*Dicksonites*) *Hughesi*, Zeiller, Pal. Indica, N.S., vol. ii, p. 6, pl. iv, figs. 1, 2, 2*a*–2*d*.

Type. ? No. 5207, Mus. Geol. Surv. India, Calcutta.

Frond tripinnate or tripinnatifid, ultimate pinnæ sub-alternate, elongate, somewhat flexuous, set at almost a right angle to the

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[1] Feistmantel (80), p. 75, pl. xvi A, figs. 1, 2, 4.

[2] Zeiller (96[2]), pp. 473, 474.

axis. Pinnules sub-opposite, membranous, oblong, deeply lobed in lower portion, less lobed above. Nerves thin, flexuous, giving off branches to each lobe.

Feistmantel[1] figured a pinnule which he regarded as showing sori "on the outer margin of the leaf lobes at the end of the veins." The same author also referred this frond to the recent genus *Dicksonia* on very insecure grounds, as Zeiller has recently pointed out, for there is at present no evidence as to the structure

B A

FIG. 32.—*Sphenopteris Hughesi* (Feist.). After Feistmantel. *A*, nat. size; *B*, a pinnule, × 3.

of the sporangia. Zeiller has suggested *Dicksonites* as a secondary generic name following *Sphenopteris*. It appears to me, however, to be better to refer this species to the latter genus alone, until we know more of the fructification.

It is very difficult in comparing highly divided, and at the same time fragmentary, portions of leaves of this type to arrive at any conclusion with regard to their identity with other and similar

[1] Feistmantel (82^1), p. 28, pl. xii, fig. 3*b*.

fragments, especially when, as in this case, considerable variation in the degree of lobing is known to occur in different portions of the same frond. The Indian species *S. Hughesi* does, however, appear to be, in certain respects, nearly identical with the Australian fronds which I have grouped together here under *S. lobifolia*. The enlarged drawings of the pinnules given by Feistmantel, and to some extent also those of Zeiller, may be closely compared in regard to the nervation with McCoy's[1] figures of *S. hastata* and *S. flexuosa*. In the Indian species, however, the rachis apparently is not winged, and in the case of some of the pinnæ the habit does not closely agree with that of the Australian fronds. It thus appears somewhat doubtful at present whether the Indian and Australian species are really distinct, but as I have not had any opportunity of seeing the specimens from India, I have maintained Feistmantel's species for the present.

S. Hughesi is known only with certainty from the Raniganj Group of the Damuda division in India.

Not represented in the British Museum collection.

3. Sphenopteris lobifolia, Morris.

(Pl. V, Figs. 2, 2*a*, 3.)

1845. *Sphenopteris lobifolia*, Morris, in Strzelecki's New South Wales, p. 246, pl. vii, figs. 3, 3*a*.
1847. *S. lobifolia*, McCoy, Ann. & Mag. Nat. Hist., vol. xx, p. 149.
S. hastata, McCoy, ibid., p. 149, pl. x, figs. 1, 1*a*.
S. flexuosa, McCoy, ibid., p. 150, pl. ix, figs. 4, 4*a*.
S. plumosa, McCoy, ibid., p. 150, pl. x, figs. 3, 3*a*.
S. germanus, McCoy, ibid., p. 150, pl. x, figs. 2, 2*a*.
1849. ? *S. lobifolia*, Dana, in Wilkes' U.S. Explor. Exped., vol. x, p. 715, pl. xii, fig. 12.
1850. *S. lobifolia*, Unger, Gen. et Spec. Plant. foss., p. 128.
S. hastata, Unger, ibid., p. 127.
S. flexuosa, Unger, ibid., p. 127.
S. germana, Unger, ibid., p. 127.
S. plumosa, Unger, ibid., p. 127.
1869. *S.* (*Hymen.*) *plumosa*, Schimper, Traité, vol. i, p. 411.
S. (*Hymen.*) *germana*, Schimper, ibid., p. 411.
S. (*Hymen.* ?) *flexuosa*, Schimper, ibid., p. 411.
S. (*Hymen.*) *hastata*, Schimper, ibid., p. 410.

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[1] McCoy (17), pl. x, fig. 1*a*; pl. ix, fig. 4*a*.

1878. *Sphenopteris lobifolia*, Feistmantel, Palaeontogr., Suppl. iii, p. 87.
S. hastata, Feistmantel, ibid., p. 88.
S. flexuosa, Feistmantel, ibid., p. 88.
S. germana, Feistmantel, ibid., p. 88.
S. plumosa, Feistmantel, ibid., p. 88.
1883. *S. lobifolia*, Tenison-Woods, Proc. Linn. Soc. New South Wales, vol. viii, p. 88.
S. hastata, Tenison-Woods, ibid., p. 90.
S. flexuosa, Tenison-Woods, ibid., p. 91.
S. germana, Tenison-Woods, ibid., p. 91.
S. plumosa, Tenison-Woods, ibid., p. 91.
1886. *S. lobifolia*, Johnston, Papers & Proc. R. Soc. Tasmania for 1885, p. 366.
S. hastata, Johnston, ibid., p. 367.
S. flexuosa, Johnston, ibid., p. 368.
S. germanus, Johnston, ibid., p. 367.
S. plumosa, Johnston, ibid., p. 367.
1887. *S. lobifolia*, Johnston, Papers & Proc. R. Soc. Tasmania for 1886, p. 173.
1890. *S. lobifolia*, Feistmantel, Mem. Geol. Surv. New South Wales, Pal., No. 3, p. 93.
S. hastata, Feistmantel, ibid., p. 92.
S. flexuosa, Feistmantel, ibid., p. 91.
S. germana, Feistmantel, ibid., p. 92.
S. plumosa, Feistmantel, ibid., p. 94.
1892. *S. lobifolia*, Jack & Etheridge, Geol. & Pal. Queensland, p. 190.
S. flexuosa, Jack & Etheridge, ibid., p. 190.
1896. *S. Morrisiana*, Johnston, Papers & Proc. R. Soc. Tasmania for 1894–5, p. 58, figs. 14, 15.
1902. *S. lobifolia*, Arber, Quart. Journ. Geol. Soc., vol. lviii, p. 11.
S. flexuosa, Arber, ibid., p. 11.
S. hastata, Arber, ibid., p. 12.
S. germana, Arber, ibid., p. 13.
Mertensia lobifolia, Shirley, Bull. 18, Geol. Surv. Queensland, p. 9, pl. v.
Sphenopteris flexuosa, Shirley, ibid., p. 10.

Types. Morris's, No. 13,530, Mus. Geol. Soc. London; McCoy's, Nos. 2, 3, 5, 7, Foreign Plant Coll., Sedgwick Mus., Cambridge.

Frond probably tripinnate, triangular in contour. Rachis winged. Pinnæ somewhat distant, elongate, broadly or narrowly linear-lanceolate, often slightly falciform, opposite in the upper portion of the frond, alternate below. Pinnules contracted at the base, somewhat distant, linear-lanceolate or oval-lanceolate; obtusely lobed. Median nerve of pinnule sinuate, supplying simple or bifurcating branches to the lobes.

I have included here, as has already been suggested by Shirley[1] and Johnston,[2] the very fragmentary fronds described by McCoy in 1847 as *Sphenopteris hastata*, *S. flexuosa*, *S. germana*, and *S plumosa*, which are probably only different portions, varying somewhat in details, of the same frond or of fronds of the same plant. The specimen on which the species *S. lobifolia* was founded shows narrow pinnules with four pairs of lobes, each of which is supplied by a bifurcating or doubly bifurcating vein. *S. germana*, McCoy, is almost indistinguishable from Morris's specimen. *S. plumosa* appears to be founded on a fragment of a pinna, in which the pinnules are a little larger and the lobes more numerous. In *S. flexuosa* the lobes are few but larger and broader, while in *S. hastata* the pinnule is only crenate and hardly lobed. All these so-called species are founded on fragments of pinnæ, far too imperfect to obtain any idea of the variation in the form and lobing which may occur on the same frond, and for the present they may best be retained under one specific name. Johnston[3] has given a full description of a more complete specimen from Tasmania, which he terms *S. Morrisiana*. It would seem best, however, to retain Morris's specific name as the oldest applied to this frond. More recently Shirley[4] has described a fragment similar in form to Morris's figured specimen, which he regards as showing the fructification. It is described as occurring "in masses on the first fork of the primary veins of each pinnule, there being one sorus for each lobe; and, as in *Gleichenia*, their modern allies, the margins of the lobes seem to have been recurved." The details of the structure of the sporangia do not appear, however, to have been made out, nor are the drawings given at all clear, and it would therefore seem premature to insist upon its botanical affinities, or to refer this frond to the recent genus *Mertensia* as Mr. Shirley has proposed.

Sphenopteris lobifolia is known only from the Permo-Carboniferous rocks of Australasia.

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[1] Shirley (02), p. 10.

[2] Johnston (87²) and (94), pt. 2, p. 58.

[3] Johnston (94), pt. 2, p. 58, figs. 14, 15.

[4] Shirley (02), p. 10, pl. v.

V. 7288. Pl. V, Figs. 2, 2*a*.

A small portion of a frond, consisting of a bipinnate, slightly winged axis, with three fairly complete pinnæ on one side and one on the other. The pinnæ are alternate, and lanceolate in contour. The axis of each pinna is grooved. The pinnules are more or less oval, and the margin is slightly lobed (Pl. V, Fig. 2*a*). They recall those figured by McCoy as *Sphenopteris hastata*.

Port Stephens, New South Wales. *Odinheimer Coll.*

V. 6251. Pl. V, Fig. 3.

A rather larger, and nearly complete fragment of an apical portion of a frond, similar to the last. Other detached pinnæ also occur on the same specimen.

Port Stephens, New South Wales. *Odinheimer Coll.*

V. 7220. Two small fragments of detached pinnæ, with oval, slightly lobed segments, showing the characteristic nervation of *S. lobifolia* very clearly.

Port Stephens, New South Wales. *Odinheimer Coll.*

4. Sphenopteris alata (Brongniart).

1834–36. *Pecopteris alata*, Brongniart, Hist. Végét. foss., p. 361, pl. cxxvii.
1836. *Aspidites alatus*, Göppert, Die Foss. Farn., p. 358.
1838. *Sphenopteris alata*, Sternberg, Flora Vorwelt, Heft vii, p. 131.
1845. *S. alata*, var. *exilis*, Morris, in Strzelecki's New South Wales, p. 246, pl. vii, figs. 4, 4*a*.
1847. *S. alata*, McCoy, Ann. & Mag. Nat. Hist. vol. xx, p. 149.
1850. *S. alata*, Unger, Gen. et Spec. Plant. foss., p. 124.
1869. *S. (Hymen.) alata*, Schimper, Traité, vol. i, p. 411.
1878. *S. alata*, Feistmantel, Palæontogr., Suppl. iii, p. 87.
S. alata, var. *exilis*, Feistmantel, ibid., p. 88.
1883. *S. alata*, Tenison-Woods, Proc. Linn. Soc. New South Wales, vol. viii, p. 89.
S. alata, var. *exilis*, Tenison-Woods, ibid., p. 90.
1886. *S. alata*, Johnston, Papers & Proc. R. Soc. Tasmania for 1885, p. 366.
1890. *S. alata*, Feistmantel, Mem. Geol. Surv. New South Wales, Pal., No. 3, p. 88.
S. alata, var. *exilis*, Feistmantel, ibid., p. 89.
1902. *S. alata*, Arber, Quart. Journ. Geol. Soc., vol. lviii, p. 9.
S. alata, Shirley, Bull. 18, Geol. Surv. Queensland, p. 11.

Type. ? Museum of the University of Edinburgh.

Frond bipinnate above, tripinnate below, sub-triangular in

contour. Rachis smooth, winged. Pinnules either confluent or contracted at the base, fairly broad, more or less deeply and irregularly pinnatifid, lobes entire or dentate. Nervation of the pinnules pinnate, simple, or bifurcate.

This species is very little known. According to Feistmantel only two specimens have been described, one of which, Brongniart's type, was obtained from the coal-mines on the Hawkesbury River, near Port Jackson, and the other, a poor specimen mentioned by McCoy, now in the Sedgwick Museum, Cambridge, is from Newcastle, New South Wales. I have had an opportunity of examining the latter, and it appears to me to be perhaps distinct from *S. lobifolia* in the habit, and in some details of the nervation, although Shirley[1] has recently expressed the opinion that these two species should be united. The pinnules are broader (1 mm.), and more ovate in many instances in the Cambridge specimen. The frond, which is incomplete, is 16·5 cm. long, and more than 20 cm. across. The pinnules are sub-opposite, with three or more bluntly and obliquely cut segments on either side, each of which is supplied by a simple or bifurcating nervule.

I have pointed out elsewhere[2] in some detail the confusion which has arisen between this plant and the plant originally described by Brongniart as *Sphenopteris alata*, now known as *S. Grandini* (Göpp.).

Sphenopteris alata (Brong.) is known only from the Newcastle Series of New South Wales.[3]

Not represented in the British Museum collection.

5. Sphenopteris, sp. (from India).

V. 7193. Badly preserved fragments, probably of a *Sphenopteris*, in which the nervation is not clearly seen.

Nágpur, India. *Sankey Coll.*

V. 7193*a*. A branched axis, presumably part of a Sphenopterid frond, but badly preserved, especially as regards the nervation.

Nágpur, India. *Sankey Coll.*

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[1] Shirley (02), p. 10. [2] Arber (02[1]), p. 10.

[3] Mr. Etheridge, jun., has expressed the opinion that this species probably also occurs in the Hawkesbury Sandstone; see Feistmantel (90), p. 89, footnote.

6. **Sphenopteris**, sp. (from Australia).

V. 4205. A portion of a frond, with the nervation preserved in places, but too fragmentary to determine specifically.

7. **Sphenopteris**, sp. (from S. Africa).

Zeiller[1] has figured a fragmentary specimen from the Transvaal, with dichotomising nerves, apparently belonging to this genus. In addition, there are two specimens, also very fragmentary, to be briefly referred to here.

V. 3622. Figured by Seward (97[1]), p. 332, text-fig. 1*a*.

A very minute fragment, with forking nerves. Probably a pinnule of a *Sphenopteris* frond.

Casey's Township, Transvaal. *Pres. by D. Draper, Esq.*, 1897.

V. 3260. Imperfect fragments of fronds. A trace of the nervation can be seen here and there.

Bedford, Cape Colony. *Pres. by D. D. Fraser, Esq.*, 1893.

Genus **PECOPTERIS**, Brongniart, 1822.

[Mém. Mus. d'Hist. Nat., vol. viii, p. 233.]

Bi-, tri-, or quadripinnate fronds. Pinnules attached by their whole base to the rachis, not contracted below, usually with parallel sides or margins slightly converging towards the apex, generally entire, with obtuse apex, contiguous, and often set almost at right angles to the rachis. Median nerve clear, giving off pinnately arranged, simple, or dichotomising nervules.

The form-genus *Pecopteris* is now generally restricted to include only certain fern-like fronds of Upper Carboniferous and Permian age, although this type of leaf is met with in the Mesozoic and Tertiary rocks, and can be closely matched among living ferns.

Pecopteris phegopteroides (Feistmantel).

1876. *Alethopteris phegopteroides*, Feistmantel, Journ. Asiat. Soc. Bengal, vol. xlv, pt. 2, p. 362, pl. xviii, figs. 1, 1*a*, 2, 2*a*.

1881. *A. phegopteroides*, Feistmantel, Flora Gondw. Syst., vol. iii, pt. 3, p. 81, pl. xviiiA, figs. 1, 1*a*, 1*b*.

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[1] Zeiller (96[1]), p. 371, pl. xviii, fig. 4.

Type. No. 5183, Mus. Geol. Surv. India, Calcutta.

Frond large, bipinnate. Rachis strong, punctate. Pinnæ set almost at right angles to the rachis. Pinnules longest in the median portion of the pinna, shorter towards base and apex, inserted slightly obliquely, oblong, incurved, contiguous, connate at the base. Median nerve of pinnule distinct, persisting to the apex, giving off simple secondary nerves at an acute angle.

The fine frond described by Feistmantel from the Raniganj Coalfield appears to me to belong to the genus *Pecopteris* rather than to *Alethopteris*. In habit and nervation it recalls some of the Pecopterids of the Upper Coal Measures and Lower Permian rocks of the Northern Hemisphere. The fructification is unfortunately unknown, and it is therefore not safe to insist, as Feistmantel has done, on its near relationship with the recent genus *Phegopteris*, which it somewhat closely resembles in the habit of the frond.

P. phegopteroides is known only from the Raniganj Group of the Damuda division in India.

Not represented in the British Museum collection.

Genus **CLADOPHLEBIS**, Brongniart, 1849.

[Tableau Genr. Végét. foss., p. 25.]

"Fronds pinnately divided, pinnæ spreading, lobes or pinnules attached by an entire base or slightly contracted towards the place of attachment, rarely somewhat auriculate, acuminate, or obtuse, occasionally dentate, especially at the apex, not rarely sub-falcately curved upwards, midrib strong at the base and towards the summit dissolving into branches, secondary veins given off at a more or less acute angle, dichotomous a little above the base, and repeatedly dichotomous." [1]

Cladophlebis is an artificial form-genus especially characteristic of the Triassic, Jurassic, and Wealden rocks. A full account of fronds of this type will be found in Mr. Seward's Catalogues of the Mesozoic Plants in the British Museum.

[1] Seward (94), p. 88.

1. Cladophlebis Roylei, Arber.

(Text-fig. 33.)

1833. *Pecopteris Lindleyana*, Royle, Illust. Bot. Himal. Mounts., p. xxix*, pl. ii, fig. 4.
1836. *Aspidites Lindleyanus*, Göppert, Die Foss. Farn., p. 360.
1845. *Pecopteris Lindleyana*, Unger, Synops. Plant. foss., p. 96.
1850. *P. Lindleyana*, M'Clelland, Rep. Geol. Surv. India, p. 56, pl. xiii, figs. 10*a–e*.
P. Lindleyana, Unger, Gen. et Spec. Plant. foss., p. 171.
1861. *Alethopteris Lindleyana*, Schimper, Traité, vol. i, p. 568.
1876. *Pecopteris Lindleyana*, Feistmantel, Rec. Geol. Surv. India, vol. ix, pt. 3, p. 76.
Alethopteris Lindleyana, Feistmantel, Journ. Asiat. Soc. Bengal, vol. xlv, pt. 2, p. 360, pl. xx, fig. 7.
1880. *A. Lindleyana*, Feistmantel, Flora Gondw. Syst., vol. iii, pts. 2, 3, p. 80, pl. xviii A, figs. 2, 2*a*; pl. xix A, figs. 3, 4; pl. xxiii A, figs. 11, 11*a*; pl. xxxix A, figs. 10, 11.
1893. *A. Lindleyana*, Oldham, Man. Geol. India, 2nd pl. opp. p. 162.
1898. ? *A. Lindleyana* (?), Shirley, Bull. 7, Geol. Surv. Queensland, p. 20, pl. xiii, fig. 1.
1901. *Cladophlebis Roylei*, Arber, Geol. Mag., dec. iv, vol. viii, p. 548.

Type. V. 4192, Geol. Dept. British Museum (Nat. Hist.).

Frond bipinnate; pinnæ spreading. Pinnules attached by their whole base, contiguous, oblong-oval, entire, or sinuate. Median nerve slender, extending to the apex; secondary nerves arising at a sub-acute angle, dichotomising. Fructification of the ? Polypodiaceous type.

The earlier figures of this species given by Royle, and especially by M'Clelland, are somewhat misleading. Feistmantel has, however, shown the nervation fairly accurately (Text-fig. 33). It is not possible, as I pointed out some years ago,[1] to adopt Royle's specific name, as the term *Pecopteris Lindleyana* had been earlier applied by Presl to a fern now known as *Coniopteris arguta* (L. & H.). Nor does this frond seem to fall naturally, as Schimper and Feistmantel have suggested, within the limits of the genus *Alethopteris*—a term now generally used in a restricted sense. The habit and especially the nervation appear to agree more closely with those of fronds included by Seward and others in the genus *Cladophlebis*, and although this genus is generally reserved for leaves of Mesozoic age I have ventured to refer this species to it,

[1] Arber (01), p. 549.

for the Indian fronds, as Feistmantel pointed out, closely resemble some of those known from the Lower Oolite of Britain and elsewhere. As a specific name I adopted '*Roylei*' in 1901 in honour of the first discoverer of this species.

Fertile fronds of this species have been described and figured by Feistmantel. The sporangia are inserted on the lateral veins of the leaflets, midway between the midrib and the margin. There are generally from six to eight sori in each row. Feistmantel has

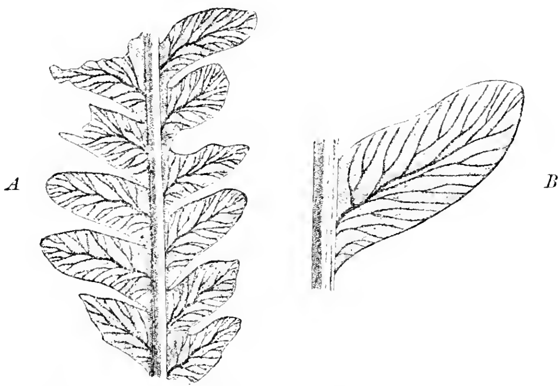

FIG. 33.—*Cladophlebis Roylei*, Arber. After Feistmantel. *A*, nat. size; *B*, a pinnule, × 2.

concluded that these fronds belong to the *Polypodiaceæ*, although the structure of the sporangia does not appear to have been made out.

This frond is known from the Raniganj Group of the Damuda division in India. It has also been identified from beds probably of Rhætic age in Queensland.[1]

V. 4192. Figured by Royle (33), pl. ii, fig. 4. *Type.*

Royle's type is a large fragment of a frond about 18 cm. long, and probably more than 20 cm. wide when perfect. The pinnæ are badly preserved, and the nervation is very indistinct. The pinnæ, of which several are seen, are alternate, and lanceolate in form. The pinnules are attached by a broad base, and are rounded at the apex. They average 1·2 cm. in length, and 8 mm. in breadth.

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[1] Jack & Etheridge (92), p. 370, pl. xvii, figs. 3, 4; Shirley (98), p. 20, pl. xiii, fig. 1.

The nervation can just be made out in places. There is a strong median nerve, giving off dichotomising secondary nerves of the *Cladophlebis* type.

Bardwán Coalfield, India.

V. 10,893. A small fragment of a pinna, not unlike that figured on Text-fig. 33A on p. 143. The nervation, however, is rather indistinct.

Near Nágpur, India. *Sankey Coll.*

2. Cladophlebis, sp. (from India).

1876. *Alethopteris* cf. *whitbyensis*, Feistmantel, Journ. Asiat. Soc. Bengal, vol. xlv, pt. 2, p. 362, pl. xxi, figs. 6, 6*a*.

1881. *Asplenium whitbyense*, Feistmantel, Flora Gondw. Syst., vol. iii, pts. 2, 3, p. 79, pl. xixA, figs. 2, 2*a*; pl. xlA, figs. 2, 3.

Feistmantel figured some very imperfect fronds from the Raniganj Group, India, which he regarded as identical with *Alethopteris indica*, O. & M., and *A. australis*, Morr., both of which are of Mesozoic age. It would be interesting if there were trustworthy evidence for the appearance of fronds of this type in rocks as old as the Permo-Carboniferous. Feistmantel's specimens, however, are far too fragmentary to warrant any such conclusion.

Genus MERIANOPTERIS, Heer, 1877.

[Flora Foss. Helvetiæ, p. 88.]

Heer described this genus as follows:—"Frons dimorpha, pinnulis fertilibus et sterilibus stipite communi affixis; pinnulæ fertiles contractæ, angustæ, nervo medio valido, nervillis secundariis simplicibus parallelis, soris interpositis, sori rotundato in quavis pinnula biseriales. Frons sterilis tripinnata, speciosa, pinnis secundariis elongatis, segmentis (vel pinnulis) nervo medio arcuato, nervis secundariis dichotomis, infimis, in arcuam acutam anastomosatis." The genus was founded for the reception of a frond from the Keuper rocks of Switzerland.

Merianopteris major, Feistmantel.

(Text-fig. 34.)

1881. *Merianopteris major*, Feistmantel, Flora Gondw. Syst., vol. iii, pt. 3, p. 83, pl. xixA, figs. 9–11.

Type. Nos. 5192–4, Mus. Geol. Surv. India, Calcutta.

Frond tripinnate, large. Secondary pinnæ broadly elongate,

lanceolate, narrowed slightly towards the apex, pinnatisect or pinnatifid. Pinnules or lobes very delicate, rounded at the apex. Median nerve distinct, somewhat curved towards the apex. Secondary nerves arising at an acute angle, dichotomous, and flexuous. The lowest pair of lateral nerves, arising from the base of the median vein, dichotomise, and then arch to join the corresponding nerves of the pinnules on either side.

Feistmantel, in his original description, states that the two lower lateral nerves of each pinnule "join with the same of the adjoining

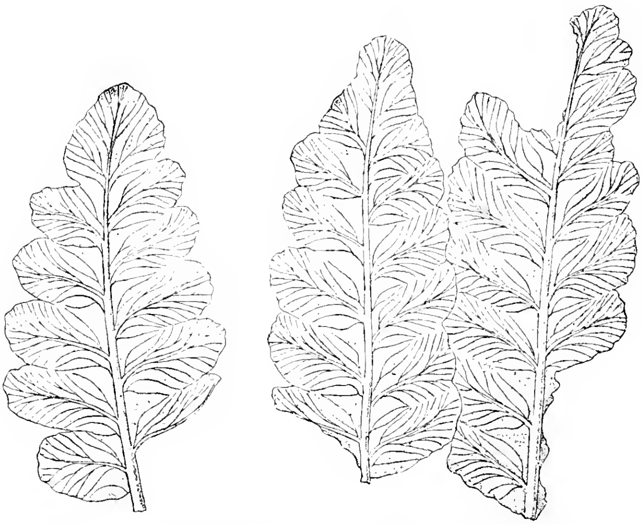

FIG. 34.—*Merianopteris major*, Feist. After Feistmantel. Nat. size.

leaflets in a pointed arch." This union is not, however, clearly shown in his figures.

This frond presents an unusual type of nervation, and is unfortunately only known from Gondwanaland by a few specimens figured by Feistmantel from the Raniganj group. Tenison-Woods,[1] however, has recorded this species from the Ballimore Coalfield of New South Wales, apparently on a higher horizon, but I am not convinced that his plant is either specifically or even generically

[1] Tenison-Woods (83), p. 114, pl. vi, figs. 2, 3.

identical with the Indian frond, although Feistmantel[1] apparently accepted this identification.

Merianopteris major is known with certainty only from the Raniganj Group of the Damuda division, India.

Not represented in the British Museum collection.

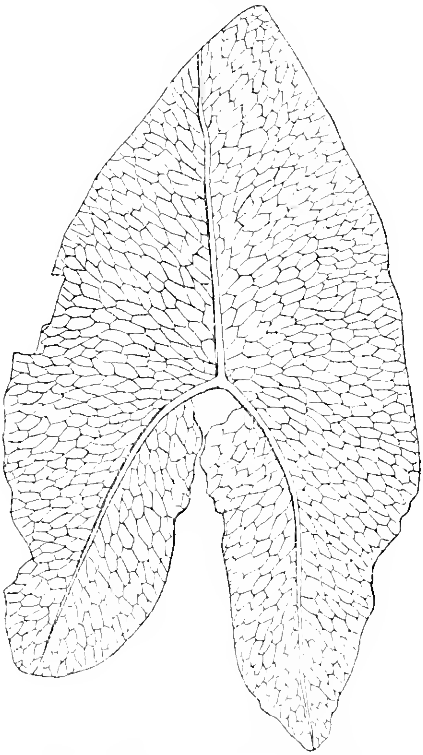

FIG. 35.—*Belemnopteris Wood-Masoniana*, Feist. After Feistmantel. Nat. size.

Genus BELEMNOPTERIS, Feistmantel, 1876.

[Journ. Asiat. Soc. Bengal, vol. xlv, pt. 2, p. 370.]

Fronds simple, broadly sagittate, petiolate. Primary nerves three in number, the median nerve being the stronger. Secondary nerves anastomosing.

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[1] Feistmantel (90), p. 113.

This genus was founded for the reception of some remarkable Indian fronds, of which only a few specimens are known. So far as I am aware, they are its only representatives.

Belemnopteris Wood-Masoniana, Feistmantel.

(Text-fig. 35.)

1876. *Belemnopteris Wood-Masoniana*, Feistmantel, Journ. Asiat. Soc. Bengal, vol. xlv, pt. 2, p. 371, pl. xx, figs. 1, 2.

1881. *B. Wood-Masoniana*, Feistmantel, Flora Gondw. Syst., vol. iii, pts. 2, 3, p. 112, pl. xliii A, figs. 3, 4.

Frond broadly sagittate, entire. Apex obtuse. Basal lobes obtusely acuminate, the median primary nerve strong, the two lateral primary nerves of the lobes thinner, all attenuated towards their extremities. Secondary nerves arising at a sub-acute angle, anastomosing, forming hexagonal or polygonal meshes. Fructification unknown.

The sagittate form of these fronds, and the large open meshes recalling the Glossopterids of the type of *G. retifera*, give a very distinctive appearance to these fossils, and it is much to be hoped that further specimens will be obtained before long which may give a clue to the affinities of this interesting plant.

Belemnopteris Wood-Masoniana is only known from the Raniganj group of the Damuda division in India.

Not represented in the British Museum collection.

STEMS OF FERNS.

Genus **PSARONIUS**, Cotta, 1832.

[Dendrolithen, pp. 27, 28.]

Arborescent stems of ferns, in which the anatomical structure is preserved. Central region of the stem consisting of a vascular cylinder of variable dimensions, with a more or less considerable number of steles. Vascular cylinder surrounded by a false cortex, often of great thickness, composed of a dense mass of adventitious roots.

Steles of the central cylinder in the form of flattened bands, bent or sinuate, arranged on several concentric circles in a groundmass of parenchymatous conjunctive tissue, anastomosing here and there, often separated by concentric bands of sclerenchyma, especially towards the periphery of the cylinder. These bands also

anastomose from time to time, and sometimes the entire vascular cylinder is surrounded by a closed sclerenchymatous band. Steles concentric, with a central strand of scalariform tracheides, surrounded by phloem. The leaf-traces arise from the peripheral steles of the cylinder, and have the form of bands concave towards the centre of the stem. The adventitious roots have a central axis consisting of a polyarch stele, formed of a variable number of radiating woody strands, with a similar number of phloem strands between them. Inner cortex of the root parenchymatous, sometimes solid, sometimes lacunal; outer cortex sclerenchymatous.

The *Psaronii* form a numerous group, which has been subdivided by Zeiller into three divisions, based on the phyllotaxis. These are the *Polystichi* with numerous vertical rows of leaves, the *Tetrastichi* with four rows, and the *Distichi* with two rows. The species described here belongs to the *Tetrastichi*.

Several species of *Psaronius* are known to have been the stems of plants possessing the *Pecopteris* type of foliage, especially the Pecopterids bearing the fructifications known as *Scolecopteris* and *Asterotheca*. Such plants present a close resemblance to a modern family of ferns, the Marattiaceæ.

Distribution.—*Permo-Carboniferous* (Northern Type):—In the Upper Carboniferous and Permian of Europe, especially the latter. *Permo-Carboniferous* (Glossopteris Type):—Brazil.

Psaronius brasiliensis, Unger.

(Plate VII.)

1831–50. *Psaronius brasiliensis*, Unger, in Martius' Hist. natur. Palmarum, i, p. lxx, pl. geol. i, fig. 4.

1872. *P. brasiliensis*, Brongniart, Bull. Soc. bot. France, ser. v, vol. xix, p. 3.

1889. *P. brasiliensis*, Bennett & Murray, Handb. Cryptog. Botany, p. 123, text-fig. 95.

1890. *P. brasiliensis*, Zeiller, Bass. houill. et perm. d'Autun et d'Épinac, fasc. ii, pt. 1, p. 246, pl. xxi, fig. 1.

1891. *P.* sp., Solms-Laubach, Fossil Botany, Eng. edit., p. 170.

1895. *P. brasiliensis*, Zeiller, Bull. Soc. Géol. France, ser. III, vol. xxiii, p. 605.

1900. *P. brasiliensis*, Scott, Stud. Foss. Botany, p. 271, text-fig. 96.

1904. *P. brasiliensis*, Solms-Laubach, Festschr. P. Ascherson's Siebzigsten Geburtst., p. 18.

Co-types. The earliest specimen, figured by Unger (No. 1446, Muséum d'histoire naturelle, Paris), is an imperfect fragment, showing only the pseudo-cortex. Although, strictly speaking, it is the type-specimen, it is impracticable to regard it as such, since it does not include the central vascular cylinder. There is also a suspicion that it was derived from the same stem in Brazil as all the other specimens now in various European museums, but it is not quite certain that this is the case. The real type would appear to be a large stem in the Museum at Rio de Janeiro, Brazil. From this trunk slabs have been cut at various periods, among which are those in the Muséum d'histoire naturelle (No. 1445) described by Brongniart, who gave the first adequate description of this species; those in the British Museum (V. 9002 and V. 5388), all of which, I believe, are now in the Geological Department; and those at Strassburg. Solms-Laubach[1] has recently traced in great detail the history of these specimens. It would perhaps be best to regard the Rio specimen and its derivatives in Paris, London, and elsewhere as co-types with Unger's specimen.

Central vascular cylinder surrounded by a continuous and closed sclerenchymatous sheath. Peripheral steles four in number, separated in part from the central region by sclerenchymatous bands, slightly curved outwards, with inrolled extremities, or sometimes folded in the form of a ring. Steles of the central region, lying internal to each of the peripheral steles, two or three in number, strongly curved, arranged radially, often divided into two, sometimes forming a closed ring. Steles lying between the peripheral steles, and often anastomosing with them at their extremities, more or less bent, longer than those nearer the centre of the cylinder.

Leaves disposed in four vertical series, probably in opposite or sub-opposite pairs. Leaf-traces on leaving the cylinder having the form of an open curve, with extremities bent in a hook-like manner.

Conjunctive tissue of the central cylinder and pseudo-cortex continuous. Inner cortex of roots not lacunal, apparently often containing numerous gum-canals arranged more or less in a circle. Vascular cylinder composed of 6–8 bundles.

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[1] Solms-Laubach (04).

Professor Zeiller has given a very full description of the detailed anatomy of this stem, from which the above account is in the main derived.

The essential features of the complex structure of the vascular cylinder can be made out from the photograph of one of the British Museum slabs reproduced on Plate VII. The central cylinder is in form nearly square, with rounded angles. For the sake of clearness we shall describe the steles with reference to the sides and angles of this square. We may first consider the steles bordering on the sides of the square. At the upper and lower borders there are two well-marked invaginations of the sclerenchymatous band, which is clearly seen completely surrounding the central cylinder. The tissues in these two bays are not preserved. These invaginations, however, mark the position at which two outgoing leaf-traces have just become free from the cylinder, and have passed out to supply a pair of opposite or sub-opposite leaves. At the sides of the square two long and slightly curved steles are seen. These will pass out from the cylinder as leaf-traces at a higher level to supply the next pair of leaves alternating with, and situated above the first pair.

The third pair of leaf-traces will arise in the same position as the first, i.e. at the upper and lower sides of the square. The steles lying immediately below the invagination at the upper side of the square will anastomose to form one of these leaf-traces. Thus the four sides of the square are, as a rule, occupied by four leaf-traces supplying four vertical rows of leaves.

The diagonal corners of the square are occupied by four long, curved steles, lying just inside the sclerenchymatous band, and projecting slightly beyond the leaf-traces. These we may speak of as the peripheral steles. It is from these peripheral steles that the adventitious roots arise. They also contribute to the leaf-traces, with which they anastomose before the latter become free from the central cylinder.

The internal portion of the square is occupied by several smaller steles, which anastomose both with the more external steles, and among themselves.

Psaronius brasiliensis is one of the most beautiful of fossil plant-remains, the colours, especially of the pseudo-cortex, as seen in polished slabs, being exceptionally striking.

The British Museum specimens were brought to this country by Claussen from Brazil, probably in 1841. The original stem in the Museum at Rio de Janeiro, from which they were derived, has been briefly described and figured by Solms-Laubach.[1]

Distribution.—Psaronius brasiliensis is known only from Brazil. The specimen figured by Unger was found between Oeiras and São Gonçala d'Amarante, in the province of Piauhy. The locality from which the stem in the Rio Museum was obtained is unknown.

V. 9002. Plate VII. Also figured by Bennett & Murray, Handb. Cryptog. Botany, p. 123, text-fig. 98, 1889. *Co-type.*

Three polished slabs of the original type-specimen are registered under this number, part of one being figured on Plate VII as seen in transverse section. The form of the slab is oval, measuring 22·5 cm. along the greater, and 18·5 cm. along the smaller axis. The pseudo-cortex, composed of adventitious roots, is considerably larger than the central cylinder. The central cylinder, the structure of which is described above, is nearly square, the diagonals measuring 11 cm.

Brazil. *Claussen Coll.*

V. 5388. A small fragment of one of the above slabs, showing part of the pseudo-cortex and vascular cylinder.

Brazil. *Claussen Coll.*

Genus **CAULOPTERIS,** Lindley & Hutton, 1832.

[Foss. Flora, vol. i, p. 121 (explan. to pl. xlii).]

External impressions or casts of stems of arborescent ferns, possessing the *Psaronius* type of internal structure, and showing the bark and the scars of the petioles. Petiolar scars large, oval, arranged in longitudinal series, generally fairly contiguous, bearing a large, concentric, closed, elliptical or horseshoe-shaped scar or band, near the apex of which a Ω-shaped vascular print occurs. The bark between the leaf-scars shows traces of many adventitious roots, like those which occur on the stems of living tree-ferns.

[1] Solms-Laubach (04), text-fig. on p. 23.

Caulopteris and *Ptychopteris* are impressions of stems, the one showing the true external surface, the other the partially decorticated condition of the same plant; the internal structure being known as *Psaronius*.

Distribution.—*Permian* and *Upper Carboniferous* (Northern Type):—Europe and N. America.

[Caulopteris ?][1] Adamsi, Feistmantel.

1878. *Caulopteris* (?) *Adamsi*, Feistmantel, Palæontogr., Suppl. iii, p. 94, pl. xii, figs. 1, 2.
1883. *C.* (?) *Adamsi*, Tenison-Woods, Proc. Linn. Soc. New South Wales, vol. viii, pp. 132–3.
1890. *C. Adamsi*, Feistmantel, Mem. Geol. Surv. New South Wales, Pal. No. 3, p. 135, pl. xxi, figs. 1, 2.

Type. ? Australian Museum, Sydney.

Feistmantel describes this species thus:—"The specimen is hardly sufficiently complete to decide its nature and systematic position with absolute certainty; but supposing it to be, what it most probably is, a fragment of a fern trunk, and, taking the disposition of the scars to be quincuncial, I thought it would be more correct to place this specimen with the genus *Caulopteris*, as there are not sufficient characters for placing it anywhere else, or for making it the type of a new genus. I have given the following diagnosis:—*Sp. Char.*—Trunco arboreo, medioeri, superficie cicatricibus ramorum (foliorum) notato; cicatricibus in quincunce (spiraliter) dispositis, transverse oblonge-ovalibus, paulum prominentibus, lateribus linea decurrente notatis; superficie interna cicatriculis parvulis vasalibus, 7 ad 8, repleta."

I am unable to see any resemblance in Feistmantel's figures to the European fern-stems included under *Caulopteris*, and I have no hesitation in saying that the attribution of these specimens to that genus is unjustified. As Feistmantel admits, they are too fragmentary to allow of exact determination. Without seeing the actual specimens I am unable to refer them to any other genus, and I have, therefore, retained Feistmantel's generic name

[1] See footnote, p. 30.

within square brackets, thus implying that, while it is incorrect, there is not sufficient evidence to justify removal at present.

This species is known only from the Newcastle Series of New South Wales.

Not represented in the British Museum collection.

INCERTÆ SEDIS.

OBSCURE STEM-STRUCTURES.

There are several fairly large, and sometimes branched stem-structures in the British Museum collection from the Nágpur district, India, some of which may possibly be fern-stems, but they do not offer sufficiently good morphological characters to permit of identification.

46,705. A stout stem, 6 cm. across, and much branched above. Surface smooth, with deep irregular grooves.

Silewáda, 12 miles north of Nágpur, India. *Hunter Coll.*

46,706. Branched stems, in one instance, tripinnate. Some of the branches are 15 cm. long, and quite smooth. The main axis of the tripinnate stem is 3 cm. across; the secondary branch is 3 mm. broad at the base, and bears fine tertiary branches.

Silewáda, 12 miles north of Nágpur, India. *Hunter Coll.*

V. 7201. A portion of a smooth stem, 13 cm. long and approximately 2·5 cm. broad.

Silewáda, 12 miles north of Nágpur, India. *Hunter Coll.*

V. 7149. A badly preserved stem, 17·5 cm. long.

Near Nágpur, India. *Hunter Coll.*

V. 9764. Another specimen, 7 cm. long and 6·3 cm. broad.

Silewáda, 12 miles north of Nágpur, India. *Hunter Coll.*

Class LYCOPODIALES.

Stem nearly always well developed, herbaceous, shrubby, or arborescent, dichotomously or monopodially branched, more rarely unbranched. Leaves simple, undivided, as a rule small in comparison with the size of the stem. Sporangia isosporous or heterosporous, simple, exannulate, usually borne singly on the upper surface or

in the axil of more or less modified leaves, which may be aggregated into strobili, or occupy a similar position to the sterile leaves. In some extinct genera the mature sporangium is enveloped by an integument, and thus was of the nature of a seed.

The living Lycopods belong to the following genera, of which *Lycopodium* (the Club-mosses), *Phylloglossum*, *Psilotum*, and *Tmesipteris* are isosporous, while *Selaginella* and *Isoetes* are heterosporous. In Palæozoic times this group was a very large and diversified one, and then attained to its maximum development; the chief genera being *Lepidodendron*, *Lepidophloios*, *Sigillaria*, and *Bothrodendron*.

All these Palæozoic types are characterised by an arborescent habit, and the power of secondary growth in thickness.

In the Mesozoic and Tertiary rocks the Lycopods are much less abundant, the genus *Lycopodites* being the chief representative, including plants more closely resembling the recent genera than the arborescent Palæozoic types.

In the Northern Permo-Carboniferous continent the Lycopods formed one of the most important elements in the flora. It is interesting to note that, while this group appears to have been entirely absent from the Southern type of vegetation in India and Australasia, it was well represented in Southern Africa and South America, where Lycopods occur in association with the Glossopteris flora. These Southern Lycopods were, however, all identical generically, and some of them specifically, with those found in Europe, North America, and Northern Asia. All the more important Palæozoic genera mentioned above have now been recorded from either Southern Africa or South America.

Family LEPIDODENDREÆ.

Arborescent Lycopods, dichotomously branched. Stem clothed with leaves or with an armour of persistent, spirally arranged, prominent leaf-bases. Leaf-bases approximate, more rarely distant and separated by bands of bark. The leaf-base consists of a leaf-cushion and a leaf-scar. The leaf-cushions are fusiform or rhomboidal. The leaf-scar varies in shape, but is usually more or less transversely elongate, and bears three prints, the central one

being the scar of the leaf-trace bundle, while the two lateral together constitute the parichnos.

Leaves (*Lepidophyllum*) simple, acicular, elongate, linear or linear-lanceolate, uninerved.

Cones (*Lepidostrobus*) heterosporous, or possibly isosporous in some cases, borne on the terminations of the finer branches, or arranged spirally, or in two opposite rows on special fructiferous branches (*Halonia* and *Ulodendron* in part). Sporangia large, elongate, borne singly on the upper surface of the spirally arranged sporophylls.

Rhizomes (*Stigmaria* in part) cylindrical, diverging from the base of the trunk as four main branches, which repeatedly bifurcate. Rootlets cylindrical, tapering distally, arranged quincuncially on the rhizome. Rootlet-scars circular, with a circular depression between the outer and somewhat raised rim, and the central vascular print.

The two more important genera of this family are *Lepidodendron* and *Lepidophloios*. These types are now known in great detail, both as regards their external morphology and internal anatomy.

Genus **LEPIDODENDRON**, Sternberg, 1820.

[Flora Vorwelt, Heft i, pp. 20 and 25.]

Stem arborescent, dichotomously branched above. The persistent leaf-bases are vertically elongate, usually longer than broad, approximate, more rarely distant and separated by bands of bark. The leaf-scar, generally placed slightly above the centre of the leaf-cushion, is rhomboidal, and as a rule somewhat broader than long. The leaf-scar bears three prints, the central leaf-trace scar, and the two lateral scars of the parichnos.

In some species a small scar, that of the ligule, occurs above the leaf-scar. The leaf-cushion below the leaf-scar in many species possesses a median ridge or keel, with or without transverse notches or grooves. The leaves (*Lepidophyllum* in part) are simple, acicular or elongately linear, uninerved. The cone (*Lepidostrobus* in part) consists of an axis bearing crowded sporophylls or bracts, usually spirally arranged, each sporophyll bearing a single, large, radially elongate sporangium on its upper surface. Rhizome (*Stigmaria* in part), see above.

Anatomy of the stem. Pith well marked, parenchymatous, or more rarely absent. Primary wood centripetal, composed of scalariform tracheides, with or without conjunctive parenchyma, either occupying the periphery of the pith, or, where a definite pith is absent, forming the central portion of the vascular cylinder. Secondary wood not always present, but, where it occurs, developed centrifugally on the outer margin of the primary wood, composed of scalariform tracheides. Cortex usually differentiated into two or more zones, the inner composed of thin-walled tissue, and the outer, consisting mainly of a periderm of thickened elements.

Lepidodendron is one of the most characteristic genera of the Carboniferous rocks of Europe and elsewhere in the Northern Hemisphere. It appears first in the Devonian, and extends to the Permian.

In addition to casts or impressions of the true external surface, others occur which are derived from more or less decorticated stems. Generic names, such as *Aspidiaria*, were at one time assigned to such fossils before their true nature had been fully realized. The name *Knorria* is one of these, which is still sometimes used to denote a particular type of Lepidodendroid cast, formed internally to the bark, which has remained as a hollow cylinder after the decay of the woody tissues. The features of such a cast are consequently the reverse of those exhibited by the inner surface of the ring of bark.

1. **Lepidodendron Pedroanum** (Carruthers).

(Pl. I, Fig. 2.)

1869. *Flemingites Pedroanus*, Carruthers, Geol. Mag., vol. vi, p. 151, pl. v.
1895. *Lepidodendron Pedroanum*, Zeiller, Compt. Rend., vol. cxxi, p. 962.
L. Pedroanum, Zeiller, Bull. Soc. Géol. France, ser. III, vol. xxiii, p. 607, pl. viii, figs. 1–4.
1896. *L. Pedroanum*, Bodenbender, Zeitschr. deutsch. geol. Gesell., vol. xlviii, table opposite p. 772.
1898. *L. Pedroanum*, Zeiller, Compt. Rend., vol. cxxvii, p. 246.

Type. V. 230. Geol. Dept. British Museum (Nat. Hist.).

Leaf-cushions and leaf-scars rather small, somewhat varied in length and breadth, in the type-specimen recalling in shape those of *Lepidodendron Veltheimianum*, Sternb. Leaf-cushions contiguous, lateral angles rounded. Leaf-scar placed at about one-third of the

length of the cushion from the apex, rhomboidal, upper and lower angles rounded, prints indistinct. Field flat, without keel or glands, and apparently without well-marked transverse ridges. Leaves short, acicular, persistent, uninerved.

Carruthers, in his original description of these fossils, says "fruit a cone?," but he merely deduces this conclusion from the occurrence of numerous detached megaspores which he regards as belonging either to *Sigillaria*, or to *Flemingites*, in close association with the stems. It was on the characters of the supposed cone that he referred these specimens to the genus *Flemingites* rather than to *Lepidodendron*.

There is no specimen of a cone among these South American fossils. The stems themselves, as Zeiller[1] has already shown, undoubtedly belong to a *Lepidodendron*, and are closely similar to European species of that genus. It is quite possible that the megaspores (see p. 175) associated with them may eventually prove to belong to *L. Pedroanum*, as Carruthers believed, but at present there is no positive evidence on this point.

Carruthers states that the leaves of *L. Pedroanum* have a parallel nervation, and figures them as such. Zeiller[2] has, however, made a more detailed study of these organs, and finds that the surface is striated longitudinally by fine and close, parallel striæ. In addition, there appear at first sight to be three parallel nerves, of which the two lateral are often better marked than the median. He shows that the central nerve is the single vascular bundle of the leaf, and that the two lateral ridges correspond to two stomatiferous furrows, such as are found to occur running longitudinally through the leaf of a *Sigillaria*.

Zeiller[2] has already pointed out that the fossils from Argentina, identified by Szajnocha[3] as *L. Pedroanum*, are not identical with Carruthers' species.

Bodenbender[4] has recorded from Argentina another *Lepidodendron*, *L. Sternbergii*, Brong., which is a typical and common species in

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[1] Zeiller (95²), p. 607; (95¹), p. 962.
[2] Zeiller (95²), p. 608.
[3] Szajnocha (91), p. 207, pl. ii, figs. 2, 3.
[4] Bodenbender (96), table opposite p. 770.

the British Coal Measures, and elsewhere in Europe. This identification may be very possibly correct, but until a description and illustrations of the specimens have been published, it would perhaps not be wise to lay any stress on the occurrence of this species in association with the Glossopteris flora.

L. Pedroanum is known only from the Serra Partida, Candiota, and from Arroyo dos Ratos, both in the province of Rio Grande do Sul, Brazil.

V. 230. Pl. I, Fig. 2. Also figured by Carruthers (69), pl. v, figs. 10 and 11, and a further specimen on pl. v, fig. 8.

A cast of a branch or stem, 6·5 cm. long and 18 mm. across, showing the contiguous, spirally arranged leaf-cushions. The cushions are 6 mm. long and 2·5 mm. broad. The upper and lower angles of the cushions are elongate, and bent in opposite directions. The lateral angles are very rounded. The leaf-scars are small and indistinct, the lower angles being rounded. The prints are not preserved. The field of the cushion below the scar is flat, without a keel or ridges, or if ridges are present they are very slight. The leaves are small, acicular. In pl. i, fig. 2, leaves are seen at the side of the specimen, apparently still attached to the stem.

V. 230*a* is a plaster cast of the above, showing the leaf-bases in relief.

On the same specimen another branch occurs, densely clothed with acicular leaves. This was figured by Carruthers on pl. v, fig. 8.

Serra Partida, Candiota, Brazil. *Pres. by N. Plant, Esq.*, 1869.

V. 230*b*. Figured by Carruthers (69), pl. v, fig. 7.

The termination of a leafy branch, clothed with leaves. The leaf-bases are not seen.

Serra Partida, Candiota, Brazil. *Pres. by N. Plant, Esq.*, 1869.

V. 230*c*. Figured by Carruthers (69), pl. v, fig. 1.

A fairly broad stem, with a few leaves still attached at the side. The features of the stem are obscure.

Serra Partida, Candiota, Brazil. *Pres. by N. Plant, Esq.*, 1869.

V. 230*d*. ? Figured by Carruthers (69), pl. v, fig. 9.

A portion of a badly preserved stem, showing the leaf-cushions, and in some instances a triangular pit representing the leaf-scar.

Serra Partida, Candiota, Brazil. *Pres. by N. Plant, Esq.*, 1869.

V. 230*e*. A small portion of a branch, showing the leaf-cushions, for the most part badly preserved. A few leaves are seen at the sides of the specimen.

Serra Partida, Candiota, Brazil. *Pres. by N. Plant, Esq.*, 1869.

V. 230*f*. Part of a branch, covered with persistent leaf-bases.

Serra Partida, Candiota, Brazil. *Pres. by N. Plant, Esq.*, 1869.

V. 230*g*. A portion of a stem or branch, the leaf-bases being obscure.

Serra Partida, Candiota, Brazil. *Pres. by N. Plant, Esq.*, 1869.

V. 230*h*. A portion of a stem, and a detached megaspore. The drawing of a leaf given by Carruthers on pl. v, fig. 6 may perhaps have been made from this specimen.

Serra Partida, Candiota, Brazil. *Pres. by N. Plant, Esq.*, 1869.

2. Lepidodendron Derbyi (Renault).

1890. *Lycopodiopsis Derbyi*, Renault, Compt. Rend., vol. cx, p. 809.
L. Derbyi, Renault, Bull. Soc. Hist. nat. d'Autun, vol. iii, p. 109, pl. ix.

1898. *Lepidodendron Derbyi*, Zeiller, Compt. Rend., vol. cxxvii, p. 245.

Type. Muséum d'histoire naturelle, Paris.

Renault[1] has described the external features of this species as follows:—

"Le premier fragment d'écorce mesure près de 1 centimètre d'épaisseur; d'une côté il présente de nombreuses cicatrices disposées très régulièrement, de l'autre une série de cavités, correspondant au passage des faiseaux vasculaires qui se rendaient aux feuilles. Les mamelons ne sont pas contigus, mais séparés par des sillons d'inégale largeur, placés légèrement en relief sur la surface de l'écorce, c'est ce relief qui donne l'existence aux sillons dont la forme est déterminée par celle des mamelons. Les mamelons sont disposés en quinconce sur deux lignes spirales croisées sous un angle de 90°. Quatre mamelons voisins forment une sorte de carré dont la diagonale transversale presque horizontale mesure 11 millimètres et la diagonale verticale 12 millimètres. Suivant sa plus grande hauteur, chaque mamelon atteint 5 millimètres et

[1] Renault (90²), pp. 110, 111.

4 millimètres suivant sa largeur. Sa forme est un ovale irrégulier à grand axe vertical. En haut de chaque côté, le contour est presque rectiligne à angle supérieur un peu arrondi, les côtés mesurent 3 millimètres environ. Le contour inférieur est plus arrondi que le contour supérieur. On ne distingue aucune trace de carène. Sur la surface du mamelon on remarque l'empreinte laissée par la base d'insertion de la feuille indiquée par une sorte de bourrelet de ce dernier qui, à la partie supérieure, fait une saillie de près d'un tiers de millimètre. La cicatrice foliaire a sensiblement la même forme que celle du mamelon, elle mesure 4 millimètres de hauteur et 2·5 mm. de largeur. Une cicatricule ponctiforme placée un peu au-dessus du milieu, à 2 millimètres et demi à partir du bord inférieur de la cicatrice foliaire, indique le passage du faisceau vasculaire pénétrant dans la feuille. Cette cicatricule est entourée d'un bourrelet saillant très net d'un millimètre de diamètre. Ni le mamelon ni la cicatrice foliaire ne présentent la trace d'autres cicatricules. Sur les rameaux plus jeunes les mamelons sont plus petits, moins oblongs, plus rapprochés, mesurant 4 millimètres environ de hauteur et 3·5 mm. de largeur."

The anatomical structure of the stem is thus described by Renault:—[1]

" Sur une coupe transversale on observe les détails suivants: au centre, une moelle cylindrique, formée de cellules polyédriques, entourée d'un cylindre ligneux. Ce dernier est constitué par des bands vasculaires disposées en lames rayonnantes simples ou soudées par leur extrémité interne, de manière à produire la configuration d'un U ou d'un V ; ces lames simples ou doubles sont séparées par des rayons cellulaires (continuation du tissu fondamental qui forme la moelle) dont les cellules, au lieu d'êtres polyédriques, se sont aplaties ou allongées dans le sens du rayon. Les trachéides qui constituent les bandes sont rayées ou réticulées, elles sont en diminuant de calibre du centre à la périphérie; les éléments trachéens paraissent être placés à l'extrémité externe des bandes. Le liber très mal conservé forme une assise continue autour de l'ensemble du cylindre ligneux. Des vides placés dans l'assise libérienne et dans l'écorce correspondent sans aucun doute au

[1] Renault (90^2), p. 116.

passage des faisceaux vasculaires se rendant aux feuilles. Il est à remarquer que ces cordons foliaires prennent naissance en face de l'intervalle qui sépare deux bandes ligneuses voisines ; il est probable que ces deux bandes se soudent chacune à l'extrémité inférieure du cordon et sont en relation conductrice avec lui."

The specimens described by the late Dr. Renault were obtained from Piracicaba, San Paulo, Brazil, where they were found in association with *Psaronius* and Cordaitean wood. They consist of two fragments showing the external or subepidermal features of the stem, and a specimen in which the internal anatomy is preserved.

Guided chiefly by the structure of the stem, Renault referred these specimens to a new genus, *Lycopodiopsis*, on the ground that the anatomy did not agree with that of any known Palæozoic member of the Lycopodiales, but presented a closer comparison with the recent genus *Lycopodium*, from which, however, it appeared to differ in certain important respects. The existence of a well-marked pith, surrounded by a discontinuous vascular ring composed of centripetally developed xylem, made up of single bundles or of bundles united internally in the form of a U or a V, are features unlike those of any Club-moss.

Professor Zeiller[1] has, however, re-examined these specimens. He has pointed out that the surface showing the leaf-cushions is somewhat decorticated, and does not represent the true external surface, but that, if allowance be made for the change in appearance due to this fact, the resemblance to a Lepidodendroid stem, such as *Lepidodendron selaginoides*, is so marked that there can be little hesitation in regarding Renault's species as a true *Lepidodendron* He finds that the vascular cylinder in reality is perfectly continuous, the apparently broad parenchymatous rays between the bundles being largely composed of badly preserved woody elements, the walls of which appear to be much thinner than the tracheides owing to alteration which has taken place during preservation. He further notices that, in the best preserved specimens, there is evidence that the outer margin of the wood was crenulated, as in *Lepidodendron Harcourtii*, and he concludes that

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[1] Zeiller (98[1]).

Renault's species is a true *Lepidodendron*, near to *L. Harcourtii*, and from the occurrence of numerous silicified leaves associated with the stem, closely resembling those of *L. Pedroanum*, he suggests that *L. Derbyi* may perhaps be only a badly preserved stem of that species.

L. Derbyi is known only from Brazil.

Not represented in the British Museum collection.

3. Lepidodendron (Knorria), sp. (from the Orange River Colony).

Kidston[1] has figured some specimens from Western Australia, including *Lepidodendron* (*Knorria*) in association with *Stigmaria*, and Lycopodean leaves. These fossils did not, however, occur in association with the *Glossopteris* flora, and the precise age of the rocks is doubtful.

V. 2900*a*, V. 2900*b*. Two sandstone casts presenting great similarity to the *Knorria* type of Lepidodendroid stem occurring in the European Coal-measures. One of these shows the impersistent longitudinal ridges fairly clearly.

Farm Zwartkoppies (at 4,600 feet s.m.), Vredefort, Orange River Colony. *Pres. by D. Draper, Esq.*, 1893.

Obscure Lepidodendroid Fossils.

V. 7596*a*, 7596*b*. Two badly preserved sandstone casts, probably decorticated stems belonging to some Lycopod, such as *Lepidodendron* or *Sigillaria*.

Sengwe Coalfield, Rhodesia.

Pres. by A. J. C. Molyneux, Esq., 1901.

V. 7594. A badly preserved, ribbed cast which I briefly described in 1903.[2] In appearance it rather recalls a *Sigillaria*, but it is impossible to determine it with confidence. The ribs are of unequal breadth, and there are no traces of leaf-scars.

Sengwe Coalfield, Rhodesia.

Pres. by A. J. C. Molyneux, Esq., 1901.

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[1] Kidston (90), p. 102, pl. iv, figs. 4–8.

[2] Arber (03), p. 290.

Genus **LEPIDOPHLOIOS,** Sternberg, 1826.

[Flora Vorwelt, Heft iv, p. xiii.]

Arborescent Lycopods, stems dichotomously branched, branches clothed with imbricated, scale-like leaf-cushions, bearing leaf-scars at or near the summit. Leaf-cushions rhomboidal, transversely elongate, smooth or keeled, upright or reflexed. Leaf-scars oval or rhomboidal, transversely elongate, the median angles usually rounded. Vascular print usually larger than the two lateral prints of the parichnos, sometimes more or less triangular in form. Leaves linear, lanceolate, uninerved. Cones of the *Lepidostrobus* type, borne on special fructiferous branches (*Halonia*), arranged spirally, ? stalked. Internal structure closely similar to *Lepidodendron*, from which it differs by a few characters, such as the crenulated outer margin of the wood.

Lepidophloios is a comparatively small genus, occurring in the Lower and Upper Carboniferous rocks of Europe and North America, and with the Glossopteris flora in South America.

Lepidophloios laricinus, Sternberg.

1820. *Lepidodendron laricinum*, Sternberg, Flora Vorwelt, Heft i, p. 23, pl. xi, figs. 2–4.
1826. *Lepidofloyos laricinum*, Sternberg, ibid., Heft iv, p. xiii.
1854. *Lepidodendron laricinum*, Geinitz, Darstell. Flora Hain.-Ebersdorfer, p. 47, pl. xi, figs. 4, 5, 7.
1855. *Lepidophloyos laricinum*, Goldenberg (pars), Flora Saræp. foss., Lief. i, p. 22, pl. iii, figs. 14, 14*a*.
Knorria, sp., Goldenberg, ibid., pp. 17, 37, pl. ii, fig. 8*b*.
1857. ? *Sigillaria Menardi*, Goldenberg, ibid., Lief. ii, p. 24, pl. vii, fig. 1.
1862. *Lepidophloios laricinum*, Goldenberg, ibid., Lief. iii, p. 30, pl. xvi, figs. 2–6.
1866. *L. acadianus*, Dawson, Quart. Journ. Geol. Soc., vol. xxii, p. 163, pl. x, fig. 45.
1870. *L. laricinus*, Schimper, Traité, vol. ii, p. 51, pl. lix, fig. 4; pl. lxiv, figs. 4, 6, 8.
L. intermedius, Schimper, Traité, vol. ii, p. 51, pl. lxiv, figs. 4–8.
1871. *L. laricinus*, Weiss, Foss. Flora jüngst. Steink. u. Rothl., p. 154, pl. xv, figs. 6, 7, 9.
L. acuminatus, Weiss, ibid., p. 155, pl. xv, fig. 8.
1873. *L. laricinus*, Carruthers, Geol. Mag., vol. x, p. 150, pl. vii, fig. 3.
1874. *L. acuminatus*, Schimper, Traité, vol. iii, p. 537.

1874. *Lepidodendron laricinum*, Feistmantel, Vers. böhm. Kohlenab., pt. 5, p. 191, pl. xxxiii, figs. 1–4; pl. xxxiv, figs. 1–4.
1878. *L. acadianus*, Dawson, Acadian Geol., 3rd ed., p. 489, text-fig. 171 on p. 457.
1880. *Lepidophloios laricinus*, Zeiller, Végét. foss. terr. houill. France, p. 113, pl. clxxii, figs. 5, 6.
1882. *L. laricinus*, Renault (pars), Cour. botan. foss., vol. ii, p. 44, pl. ix, figs. 5, 7.
1884. ? *L. dilatatus*, Lesquereux, Coal Flora, vol. iii, p. 781, pl. cv, fig. 2.
1886. *L. laricinus*, Zeiller, Flore foss. bass. houill. Valenciennes, p. 471, pl. lxxii, figs. 1, 2.
1888. *L. acadianus*, Dawson, Geol. Hist. Plants, p. 166, fig. 44 on p. 121.
1890. *L. laricinus*, Renault, Flore foss. terr. houill. Commentry, p. 514, pl. lxi, fig. 1.
1891. *L. acadianus*, Dawson, Geol. Nova Scotia (Acad. Geol., 4th Edit.), p. 456, fig. 171 on p. 457.
1893. *L. laricinus*, Kidston, Trans. Roy. Soc. Edinb., vol. xxxvii, pt. 3, p. 555, pl. i, figs. 4, 4*a*; pl. ii, figs. 8, 8*a*, 8*b*.
1895. *L. laricinus*, Zeiller, Compt. Rend., vol. cxxi, p. 962.
L. laricinus, Zeiller, Bull. Soc. Géol. France, ser. III, vol. xxiii, p. 612, pl. ix, figs. 1–3, 1*a*, 2*a*.
1898. *L. laricinus*, Potonié, Lehrb. Pflanzenpal., Lief. iii, p. 240, text-fig. 226.
L. laricinus, Zeiller, Mém. Soc. Géol. France, vol. viii, Mém. No. 21, p. 74.
1900. *L. laricinus*, Scott, Stud. Foss. Bot., p. 160.
L. laricinus, Zeiller, Élém. Paléobot., p. 186, text-fig. 128.
1902. *L. laricinus*, Kidston, Proc. Yorks. Geol. & Polyt. Soc., vol. xiv, p. 348, pl. lvi, fig. 2.
1904. *L. laricinus*, Zalessky, Mém. Com. Géol., N.S., vol. xiii, pp. 30, 99, pl. v, fig. 9; pl. vi, figs. 8, 10; pl. vii, figs. 1, 2; pl. viii, figs. 7, 9.

"Leaf-cushions elongated, imbricate, scarcely keeled, directed downwards; exposed portion of cushions rhomboidal or elongated transversely; lateral and upper angles acute, lower angle generally rounded. Leaf-scar placed at the summit of the downward directed leaf-cushion, or only slightly below the summit, rhomboidal, or transversely rhomboidal-elongate, lateral angles very sharp and prominent, upper and lower angles slightly rounded; within the leaf-scar are three cicatricules placed centrally, or slightly above or below the centre, the two lateral punctiform, the central punctiform or sub-triangular. When the leaf-scar is placed slightly below the apex of the deflexed cushion two lines run from its lateral angles, which meet the margin of the cushion a short distance below the leaf-scar. The leaf-cushion freque tly

bears, immediately beneath the leaf-scar, a small tubercle with a circular or sub-triangular depression. Fructification borne on Halonial branches."

The above description is that given by Mr. Kidston[1] in his memoir on the genus *Lepidophloios*.

L. laricinus is an Upper Carboniferous species, found comparatively rarely in the British Coal Measures, but more abundantly in Continental beds of similar age. Zeiller[2] in 1895 showed that this plant also occurs associated with the Glossopteris flora in Brazil; another instance of the identity of the Lycopodean element of the Permo-Carboniferous flora both in the Northern and Southern Hemispheres.

It may be also noticed that Johnston[3] has figured a small and imperfect fragment from Tasmania as being possibly a *Lepidophloios*, which he also compares with *Sigillaria Brardi*; but for the present this record must remain doubtful.

Distribution.—Permo-Carboniferous (Glossopteris flora):—Brazil. *Upper Carboniferous* (Northern Type):—Britain, France, Germany, Austria, Russia, North America, and elsewhere.

L. laricinus is represented in the British Museum collection by both British and foreign examples belonging to the Northern flora.[4] There are, however, no specimens from Brazil.

Family BOTHRODENDREÆ.

Arborescent Lycopods, dichotomously branched. Leaf-cushions absent or feebly developed. Leaf-scars distant, small, oval, bearing three prints. Bark ornamented with delicate striæ, or smooth. Leaves small, linear-acuminate, or lanceolate. Cones similar in form to *Lepidostrobus*, borne terminally, or in two opposite longitudinal rows on the stem.

The Bothrodendreæ, consisting of a single genus *Bothrodendron*, is a small but interesting family of arborescent Lycopods of great antiquity, appearing first in the Upper Old Red Sandstone of the

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[1] Kidston (93), p. 556.
[2] Zeiller (95¹), p. 962; (95²), p. 617, pl. ix, figs. 1–3, 1*a*, 2*a*.
[3] Johnston (88), p. 111, pl. viii, fig. 2.
[4] See Kidston (86), p. 169.

south of Ireland, and in the Devonian rocks of Australia and the Arctic regions. It recalls certain of the Sigillariæ, especially the Subsigillariæ of the *Leiodermaria* section, and also shows affinities in the type of cone to the Lepidodendreæ. It may probably be regarded as occupying an intermediate position between these two families.

Genus **BOTHRODENDRON**, Lindley & Hutton, 1833.

[Foss. Flora, vol. ii, explan. to pls. lxxx, lxxxi.]

Leaf-cushions only found on the smaller or younger branches, approximate, elongate, rhomboidal, slightly raised. Leaf-scars small or minute, transversely oval, usually distant, separated by broad bands of bark, more rarely on leaf-cushions. Leaf-scars bearing two lateral, and one central, minute, punctate prints. In some species a small print also occurs immediately above the leaf-scar. Bark ornamented by series of fine wrinkles or striæ, straight or flexuous, arranged longitudinally, transversely, or in both directions, sometimes smooth. Leaves small, linear or lanceolate, uninerved. Cones similar in type to *Lepidostrobus*. Internal structure of the stem for the most part similar to *Lepidodendron*.

The genus extends from the Upper Devonian to the Coal Measures, and possibly to the Permian.

Bothrodendron Leslii, Seward.

(Text-fig. 36.)

1903. *Bothrodendron Leslii*, Seward, Ann. S. African Mus., vol. iv, pt. 1, p. 87, pl. xi, figs. 1, 1*a*, 1*b*, 4, 5, 6.

Type. S. African Mus., Cape Town.

Dichotomously branched, cylindrical stems without leaves, 6–25 mm. in breadth. Leaf-cushions absent. Leaf-scars small, transversely oval or subcircular, numerous, not very distant or almost crowded, prominent with a central depression, or occurring as a depression with a central umbo having a small pit in the centre. Bark smooth or somewhat wrinkled.

The largest specimen figured by Mr. Seward is 29 cm. long, and is partially decorticated, especially in the lower portion.

Mr. Seward[1] has concluded that while some of the characters of these specimens do not agree in detail with those of *Bothrodendron*, this probably may be explained by taking into account the partially decorticated nature of the fossils, in which state there would naturally be no trace of the parichnos scars or of the ornamentation of the bark.

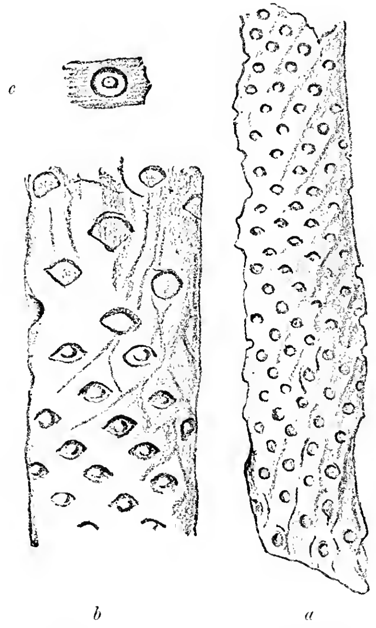

FIG. 36.—*Bothrodendron Leslii*, Seward. After Seward. *a*, nat. size; *b*, *c*, slightly enlarged.

The apparently dichotomous branching in these specimens is an argument in favour of referring them to the Lycopodiales rather than to the Gymnosperms. The same author has also concluded that the South African fossils bear so close a superficial resemblance to *Bothrodendron kiltorkense* (Haughton), which occurs in the Devonian rocks of the South of Ireland, and of Bear Island in the Arctic

[1] Seward (03[1]), pp. 90, 91.

regions, that one might be almost tempted to refer them to that species, but nevertheless he believes them to be distinct.

The fragments from India, figured by Feistmantel[1] as Coniferous stems of ? *Rhipidopsis*, have a superficial resemblance to the South African specimens. Mr. Seward has, however, decided that the Indian fossils are too imperfect to afford any evidence as to their real nature.

Bothrodendron Leslii is known only from Vereeniging in the Transvaal, South Africa.

Not represented in the British Museum collection.

Family SIGILLARIÆ.

Arborescent Lycopods, stems unbranched or very rarely dichotomously branched. Stem longitudinally ribbed or without ribs, bark smooth, often ornamented. Leaf-scars hexagonal, lateral angles prominent, median angles usually rounded, often emarginate above. Prints of the leaf-scar three, the central vascular print punctate, the lateral prints of the parichnos crescentic or straight.

Leaves linear-lanceolate or elongate linear, uninerved. Cones (*Sigillariostrobus*) either stalked and borne in irregular whorls on the stem, or sessile in two opposite vertical rows on a fructiferous branch (*Ulodendron* in part). Sporangia heterosporous, large, elongate, borne on the upper surface of the sporophylls or bracts, which are spirally arranged or whorled.

Rhizome (*Stigmaria* in part) similar to that of *Lepidodendron*.

Internal structure similar to *Lepidodendron*, differing only in details.

The family Sigillariæ is represented by a single type of stem, *Sigillaria*, a genus appearing first in the Lower Carboniferous and probably extending to the Bunter (Trias).

Genus **SIGILLARIA**, Brongniart, 1822.

[Class. Végét. foss., pp. 209, 222.]

External surface of the stem longitudinally ribbed (*Eusigillarian* type) or without ribs (*Subsigillarian* type). Leaf scars contiguous

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[1] Feistmantel (80), p. 124, pl. xlvii A, figs. 5–7.

or distant, hexagonal, all the angles, except the lateral, being usually more or less rounded. Central vascular print small; prints of the parichnos larger, crescentic or straight. A small print often occurs above the leaf-scar. Bark smooth or ornamented.

Leaves linear-lanceolate or elongate linear, uninerved. Cone (*Sigillariostrobus*), rhizome (*Stigmaria* in part).

Anatomy of the stem. Pith well marked, parenchymatous. Centripetal primary wood forming a continuous ring or composed of separate bundles, crenulated at the periphery, consisting of scalariform or reticulated tracheides, with small spiral tracheides forming the protoxylem groups. Leaf-traces arising in the bays or indentations at the periphery of the primary wood. Secondary wood centrifugal, forming a continuous ring, as in *Lepidodendron*, consisting of scalariform tracheides pitted on both the tangential and radial surfaces. Cortex differentiated into two or more zones, the outer consisting of thick-walled periderm.

The *Sigillariæ* are divided into two main groups, the *Eusigillariæ*, with ribbed stems, and the *Subsigillariæ*, without ribs. Further subdivisions have been proposed, and while it is now known that these are without taxonomic importance, certain names are still sometimes used to denote a particular type of stem-cast. Thus the *Subsigillariæ*, the group to which the specimens described here belong, have been divided into two subgroups. The *Clathrariæ* include stems in which the leaf-scars are placed on contiguous, rhomboidal cushions, usually somewhat elevated, the cushions being separated by well-marked oblique furrows. In the *Leiodermarian* type there are no leaf-cushions, the leaf-scars being distant and separated by bark, which is ornamented in various ways by striæ. Both these types may occur on the same specimen, as in the case of *Sigillaria Brardi*, which is found in South Africa in association with *Glossopteris*.

Sigillaria first appears in the Lower Carboniferous, but is neither very abundant nor represented by many species in these rocks. The genus reaches its maximum in the Upper Carboniferous. In the Permian it is less frequent, and probably dies out at the end of that period with the exception of one species which is known to persist into Triassic times.

Sigillaria Brardi, Brongniart.

(Pl. VIII, Fig. 1.)

1822. *Clathraria Brardii*, Brongniart, Class. Végét. foss., p. 222, pl. xii, fig. 5.
1826. *Favularia Brardi*, Sternberg, Flora Vorwelt, Heft iv, p. xiv.
1828. *Sigillaria Brardii*, Brongniart, Prodr. Hist. Végét. foss., p. 65.
1836. *S. Brardii*, Brongniart, Hist. Végét. foss., p. 430, pl. clviii, fig. 4.
S. rhomboidea, Brongniart, ibid., p. 425, pl. clvii, fig. 4.
S. Menardi, Brongniart (pars), ibid., p. 430, pl. clviii, fig. 6.
Lepidodendron Ottonis, Göppert, Syst. filic. foss., p. 462, pl. xlii, figs. 2, 3.
1839. *Sigillaria elegans*, Brongniart, Arch. Mus. hist. nat., vol. i, p. 405, pls. xxv–xxviii.
1845. *S. elegans*, Corda, Flora Vorwelt, p. 24, pls. vii, viii.
S. Brardii, Germar, Vers. Steink. Wettin, Lief. iii, p. 29, pl. xi, figs. 1, 2.
1848. *S. spinulosa*, Germar, ibid., Heft v, p. 58, pl. xxv, figs. 1, 2.
1855. *S. elegans*, Goldenberg, Flora Saræp. foss., Lief. i, p. 26.
1857. *S. Brardii*, Goldenberg, ibid., Heft ii, p. 25, pl. vii, figs. 7, 8.
S. rhomboidea, Goldenberg, ibid., p. 22, pl. vi, fig. 6.
S. Menardi, Goldenberg (pars), ibid., p. 24, pl. vii, figs. 1, 2.
S. elegans, Goldenberg, ibid., p. 27, pl. v, figs. 6–13.
S. spinulosa, Goldenberg, ibid., p. 20, pl. x, fig. 5.
1860. *Lepidodendron sexangulare*, Eichwald, Lethæa Ross., vol. i, p. 114, pl. v, fig. 8.
1864. *Sigillaria denudata*, Göppert, Foss. Flora Perm. Form., p. 200, pl. xxxiv, fig. 1.
S. Brardi, Göppert, ibid., p. 201.
1870. *S. Brardii*, Schimper, Traité, vol. ii, p. 102, pl. lxvii, figs. 10, 11.
S. Menardi, Schimper, ibid., p. 103.
S. spinulosa, Schimper, ibid., p. 102, pl. lxvii, fig. 12.
1871. *S. Brardii*, Weiss, Foss. Flora jüngst. Steink. u. Rothl., Heft ii, p. 161, pl. xvi, fig. 1; pl. xvii, figs. 7–9.
S. denudata, Weiss, ibid., p. 159, pl. xvi, fig. 3.
1875. *S. spinulosa*, Renault & Grand'Eury, Mém. Acad. Sci. France, vol. xxii, No. 9, p. 1, pls. i–v; pl. vi, figs. 33, 34.
1880. *S. Brardi*, Zeiller, Végét. foss. terr. houill. France, p. 135, pl. clxxiv, fig. 1.
S. rhomboidea, Zeiller, ibid., p. 137, pl. clxxiv, fig. 2.
1881. *S. Brardii*, Renault, Cours bot. foss., vol. i, p. 129, pl. xvii, fig. 1.
S. elegans, Renault, ibid., p. 143, pl. xviii, figs. 1–10.
S. spinulosa, Renault, ibid., p. 130, pl. xvii, fig. 2.
S. Brardii, Feistmantel, Archiv. naturwiss. Landes. Böhmen, vol. iv, No. 6, Geol. Abth., p. 88, pl. v, figs. 1, 1*a*, 2.
S. denudata, Feistmantel, ibid., p. 86, pl. v, figs. 3, 3*a*.
1882. *S. Brardi*, Weiss, Aus Steinkohlenf., 2nd ed., p. 7, pl. iii, fig. 22.

1882. *Sigillaria denudata*, Weiss, ibid., p. 7, pl. iii, fig. 23.

1886. *S. Menardi*, Weiss, Sitz.-ber. Gesell. naturforsch. Freunde, Berlin, for 1886, No. 2, p. 8, fig. 2 on p. 9.

S. cf. *elegans*, Weiss, ibid., p. 8, fig. 1 on p. 9.

1888. *S. Brardi*, Weiss, Zeitschr. deutsch. geol. Gesell., vol. xl, p. 569, fig. 4.

S. Wettinensis, Weiss, ibid., p. 569, fig. 8.

1889. *S. Brardi*, Zeiller, Bull. Soc. Géol. France, ser. III, vol. xvii, p. 603, pl. xiv.

S. Brardi, Weiss, Zeitschr. deutsch. geol. Gesell., vol. xli, p. 377.

S. spinulosa, Weiss, ibid., p. 377.

1890. *S. Brardi*, Seward, Geol. Mag., dec. III, vol. vii, p. 213.

S. Brardi, Renault, Flore foss. terr. houill. Commentry, pt. ii, p. 539, pl. lxiii, fig. 1.

S. Brardii, Grand'Eury, Bassin houill. du Gard, p. 250, pl. xi, fig. 1.

1892. *S. Brardi*, Zeiller, Flore foss. bass. houill. et perm. de Brive, p. 83, pl. xiv, fig. 1.

1893. *S. mutans*, Weiss & Sterzel, Abhand. k. preuss. geol. Landesanst., N.F., Heft ii, p. 88.

S. mutans, forma :

denudata, Weiss & Sterzel, ibid., p. 92, pl. viii, fig. 39.
denudata β, var. *carbonica*, Weiss & Sterzel, ibid., p. 94.
rectestriata, Weiss & Sterzel, ibid., p. 94, pl. ix, fig. 42.
subrectestriata ,, ,, p. 96, pl. ix, figs. 44, 45.
epulvinata ,, ,, p. 97.
subcurvistriata ,, ,, p. 98, pl. ix, fig. 43.
undula ,, ,, p. 100, pl. ix, fig. 46.
latareolata ,, ,, p. 102, text-fig. 6.
subspinulosa ,, ,, p 105, pl. xi, figs. 51, 52.
spinulosa ,, ,, p. 106, pl. x, figs. 47, 50; pl. xi, fig. 50*a*.
Wettinensis-spinulosa ,, ,, pp. 108, 127.
Lardinensis-Brardi ,, ,, p. 110.
pseudo-rhomboidea ,, ,, p. 112, pl. x, fig. 48.
radicans ,, ,, p. 114, pl. x, fig. 49; pl. xi, figs. 49*a*, 49*b*.
laciniata ,, ,, p. 116, pl. xi, fig. 53.
rhomboidea ,, ,, p. 117.
subrhomboidea ,, ,, p. 118, pl. xii, fig. 54.
subleiodermaria ,, ,, p. 120, pl. xix, fig. 72.
Wettinensis ,, ,, p. 122, pl. viii, fig. 55*a*; pl. xii, figs. 55, 56; pl. xiii, figs. 57, 58.
cancellata ,, ,, p. 128, pl. xv, fig. 62.
urceolata ,, ,, p. 130, pl. xiv, fig. 59.
Brardi ,, ,, p. 131.

1893. *Sigillaria mutans*, forma *Brardi*, var.:
typica, Weiss & Sterzel, ibid., p. 133, pl. xv, fig. 60; pl. xx, fig. 82.
Ottonis ,, ,, p. 138, pl. xvi, fig. 65.
catenaria ,, ,, p. 139.
sublævis ,, ,, p. 142, pl. xvi, fig. 63.
punctieulata ,, ,, p. 143, pl. xvii, fig. 67.
Ottendorfensis ,, ,, p. 143, pl. xx, fig. 77.
Germari-varians ,, ,, p 145, pl. xv, fig. 61; pl. xvii, fig. 66.
subcancellata ,, ,, p. 154, pl. xix, fig. 73.
S. mutans, forma *Menardi*, Weiss & Sterzel, ibid., p. 156.
S. mutans, forma *Menardi*, var.:
Cisti, Weiss & Sterzel, ibid., p. 157.
sub-Brardi ,, ,, p. 158.
Autunensis ,, ,, p. 159.
varians ,, ,, p. 160, pl. xviii, figs. 68, 69, 71.
subquadrata ,, ,, p. 163, pl. xix, fig. 74.
Alsenziensis ,, ,, p. 164, pl. xx, fig. 78.
minima ,, ,, p. 165, pl. xx, fig. 80.
approximata ,, ,, p. 166, pl. xix, fig. 76.
S. mutans, forma *farulina*, Weiss & Sterzel, ibid., p. 168, pl. xviii, fig. 70.
,, ,, *Heeri*, Weiss & Sterzel, ibid., p. 170, pl. xix, fig. 75.
S. ambigua, Weiss & Sterzel, ibid., p. 172, pl. xx, fig. 79.
S. Brardii, Potonié, Flora Rothl. Thüringen, p. 190, pl. xxvii, fig. 2.
1896. *S. Brardii*, Kidston, Proc. R. Soc. Edinb., vol. xiii, p. 233, pl. vii.
1897. *S. Brardi*, Seward, Quart. Journ. Geol. Soc., vol. liii, p. 326, pl. xxiii, fig. 2; pl. xxii, fig. 3; text-figs. *2a–p* on p. 327, and text-fig. 3 on p. 329.
1900. *S. Brardi*, Scott, Studies Foss. Bot., p. 193, text-fig. 75 on p. 190.
S. Menardi, Scott, ibid., p. 196, text-fig. 76 on p. 197.
S. spinulosa, Scott, ibid., p. 200, text-figs. 77–79 on pp. 201, 205.
S. Brardi, Zeiller, Élém. Paléobot., p. 193, text-fig. 136 on p. 193.
1901. *S. Brardi*, Kidston, Trans. Nat. Hist. Soc. Glasgow, N.S., vol. vi, pt. 1, p. 93, text-fig. 17 on p. 91.
1902. *S. Brardi*, Kidston, Proc. Yorks. Geol. Polyt. Soc., vol. xiv, pt. 3, pl. lviii, fig. 2; pl. lix, fig. 1.

Type. Muséum d'histoire naturelle, Paris.

Leaf-scar rhomboidal, as long as broad, but often broader than long; upper margin rounded, flattened, or notched, lower margin rounded, sides generally convex with sharp lateral angles. Prints three, placed slightly above the centre of the leaf-scar, the central print transversely linear, generally concave, the two lateral oblique, frequently lunate, embracing the central print; above the leaf-scar there is frequently a small circular print.

A definite limit of the leaf-cushion often absent (*Leiodermaria*), occasionally incomplete, or distinct (*Clathraria*). Leaf-cushion, when present, more or less elevated, generally rounded above and below, or subquadrate or spathulate with truncated base, and generally without any surface ornamentation. Leaf-scar usually on the upper portion of the cushion, central only in the young condition. In the Leiodermarian forms the outer surface of the bark, between the leaf-scars, is generally ornamented with a shagreen-like sculpturing of fine longitudinal ridges and delicate transverse striæ. The longitudinal lines are longer and coarser than the fine transverse striæ; under the leaf-scar the bark is frequently smooth—above the leaf-scar it is generally smooth.

Immediately beneath the leaf-scar on certain Leiodermarian forms there sometimes occur one or two small circular scars. Cortex thin—decorticated stem longitudinally striated. The cone-scars form an irregular girdle round the stem. They are small, circular, oval, or subtriangular, and in the Clathrarian forms are placed on small cushions inserted between the leaf-scars, which, like the cone-scars, are usually more or less deformed by mutual pressure. In the Leiodermarian forms they possess no cushion, and are circular from the absence of all pressure. The internal anatomy of the stem has the characters described above under the genus.

Mr. Kidston[1] published some years ago a full account of this species and its variations, from which the above description, with the exception of a few verbal alterations and additions, is taken. He has confirmed the conclusion that *S. Menardi*, Brong., *S. spinulosa*, Germar, and *S. denudata*, Göpp., are merely varieties of *S. Brardi*, Brong.

The internal anatomy of at least two varieties of *S. Brardi* is known, but as the South African specimens described below are not petrified, the structure of the stem need not be dealt with in detail here.[2]

[1] Kidston (96); see also the papers by Zeiller (89), Weiss & Sterzel (93), Seward (90) mentioned above.

[2] For a full account of the anatomy of *S. Brardi* see the memoirs by Brongniart (39), Renault & Grand'Eury (75), Corda (45), & Scott (00) given in the list of synonyms.

Distribution. — *Upper Carboniferous* and *Permian* (Northern Type):—Europe:—Britain, France, Germany, Austria, Russia, and elsewhere; ? North America:—Pennsylvania. *Permo-Carboniferous* (Glossopteris Type):—South Africa:—Transvaal.

V. 3623. Pl. VIII, Fig. 1. Also figured by Seward (97[1]), p. 326, pl. xxiii, fig. 2, and text-figs. 2*a*–*e* on p. 327.

A part of this fossil is figured on Pl. VIII, Fig. 1, showing the spirally arranged leaf-scars, which in the upper portion are fairly well preserved. The entire specimen, which is a sandstone cast, measures 18 cm. in length and 12 cm. broad. The leaf-scars are 9 mm. broad and 7 mm. in height. The stem had become decorticated to some extent before preservation took place, especially in the lower portion, consequently the characteristic features of a Sigillarian leaf-scar—the central vascular print and the two lateral crescentic prints of the parichnos—are not preserved. But on one or two of the scars in the upper portion the vascular print may be seen and also the parichnos, which is usually represented by a V-shaped projection. Enlarged drawings of several of these scars, accompanied by a full description, have been given by Mr. Seward.[1]

The leaf-scars are closely set, and between them occur narrow sloping ridges of sandstone, which represent the grooves separating the leaf-scars in the living state.

Vereeniging, Transvaal. *Pres. by D. Draper, Esq.*, 1897.

V. 3617. Figured by Seward (97[1]), p. 330, text-fig. 3 on p. 329.

A small piece of a stem, partially decorticated, showing a cast of the internal tissues (*Syringodendron* type). On one side, however, the leaf-scars are plainly seen, and they resemble those of the previous specimen.

Vereeniging, Transvaal. *Pres. by D. Draper, Esq.*, 1897.

Sigillaria, sp., cf. *Sigillaria Brardi.*

V. 3616. Figured by Seward (97[1]), p. 330, pl. xxii, fig. 3.

A faint sandstone impression of a badly preserved stem with

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[1] Seward (97[1]), text-fig. 2 on p. 327, and pp. 328, 329.

leaf-scars rather smaller than in the previous specimens. I agree with Mr. Seward in regarding this as probably a smaller form of *S. Brardi.*

Vereeniging. *Pres. by D. Draper, Esq.*, 1897.

V. 3618. Figured by Seward (97[1]), p. 330, pl. xxii, fig. 4*a*; pl. xxiv, fig. 3, and text-fig. 2*f* on p. 327.

A fairly well-preserved portion of a broad stem occurring in association with *Glossopteris* and other genera. Some of the best preserved of the leaf-scars have been studied in detail by Mr. Seward, who has discussed the nature of this specimen, and has expressed some uncertainty as to its affinities.

Vereeniging. *Pres. by D. Draper, Esq.*, 1897.

V. 8324. Described by Seward (98[2]), pp. 92, 93.

A sandstone cast of a fairly broad stem showing the leaf-scars, which for the most part are badly preserved.

Vereeniging. *Pres. by Dr. F. H. Hatch*, 1898.

[**V. 233.** *Sigillaria* (*Syringodendron*), sp. A decorticated, ribbed *Sigillaria* bearing the record "Coal shale from the Stormberg with impression of Calamites." There is every reason to believe that this specimen was not derived from South Africa. See Historical Sketch under heading Cape Colony.]

LYCOPODEAN SPORES.

Carruthers,[1] in 1869, figured a number of megaspores, some of which were associated with the type-specimens of *Lepidodendron Pedroanum.* These bodies he speaks of as sporangia, but there can hardly be any doubt that they are megaspores. They are of fairly large size, about 2 mm. in diameter, and are flattened discs, yellow in colour. Many of the specimens are crushed and broken, but some of them appear to have a narrow rim surrounding a somewhat raised central disc, and, on one surface, a triradiate ridge.

Zeiller[2] has also noticed and described these bodies, pointing out that they very closely resemble those of *Sigillariostrobus Tieghemi*,

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[1] Carruthers (69), pl. v, figs. 2–5.

[2] Zeiller (95[1]), p. 962, and (95[2]), p. 609, text-fig. 2.

and since the megaspores of cones of *Lepidodendron* are not known to attain to such a size, he does not agree with Carruthers in regarding them as probably referable to *Lepidodendron Pedroanum*.

Zeiller has also described other spores from Brazil, some of which he figures as microspores,[1] and others as possibly pollen-grains.[2]

Lycopodean Megaspores from Brazil.

V. 231. A piece of brownish shale showing a few detached megaspores.

Candiota, Rio Grande do Sul. *Pres. by N. Plant, Esq.*, 1869.

V. 231 *a*. Figured by Carruthers (69), pl. v, fig. 4.

A detached megaspore.

Candiota, Rio Grande do Sul. *Pres. by N. Plant, Esq.*, 1869.

V. 231 *c*. ? Figured by Carruthers (69), pl. v, fig. 2.

A detached megaspore, probably one of those figured by Carruthers.

Candiota, Rio Grande do Sul. *Pres. by N. Plant, Esq.*, 1869.

V. 231 *b*, **V. 231** *d–i*. Several specimens showing megaspores similar to those figured by Carruthers.

Candiota, Rio Grande do Sul. *Pres. by N. Plant, Esq.*, 1869.

Spores of Unknown Affinity.

[*Tasmanites punctatus*, Newton.]

The nature of the minute discs occurring abundantly in the Tasmanite and Australian White Coal of the Mersey River Beds in Tasmania (Permo-Carboniferous), to which Newton[3] gave the name *Tasmanites punctatus*, has been much discussed by several authors.[4] They have been regarded as sporangia, algæ, spores, and scales, but there is no doubt that they are of the nature of spores, although of what particular type of plant there is no evidence to show. They can, however, hardly be of Lycopodean

[1] Zeiller (95[2]), p. 611, text-figs. 3–5.

[2] Zeiller (95[2]), p. 612, text-figs. 6, 7.

[3] Newton (75), p. 337, pl. x.

[4] For a full bibliography on this subject see Etheridge (78), pp. 199, 200; see also Feistmantel (90), p. 143.

origin, since Lycopods are unknown at present from Australasia in association with the Glossopteris flora. The discs vary in diameter from ·3–·5 mm. Newton describes them as "more or less circular bodies somewhat thickened towards the circumference, many of them having their surfaces raised into irregular folds." The walls of the sacs are dotted, the dots being "minute lines (tubes?) passing from the outer to the inner surface." The spores are brownish in colour, and usually compressed.

The examination of the two specimens in the collection showing these spores has not thrown any fresh light on their structure or nature. It appears to me to be hardly necessary to retain the name *Tasmanites punctatus*.

V. 4010. A piece of sandy shale showing a large number of minute, rounded spores.

Mersey River, Tasmania. *Pres. by G. Sweet, Esq.*, 1900.

V. 3778. A similar specimen showing numerous yellowish spores.

Mersey River, Tasmania. *Pres. by T. Stephens, Esq.*, 1896.

Group GYMNOSPERMEÆ.

Trees or shrubs with homoxylous wood (except Gnetaceæ). Flowers always unisexual, and as a rule without perianth (except Gnetaceæ). Ovules and seeds naked, not enclosed in carpels. Seed endospermous, endosperm being formed before fertilisation. Anemophilous plants.

There are five great classes of Gymnosperms, four of which, viz., the Cycadophyta, Ginkgoales, Gnetaceæ, and Coniferales, are represented in the flora of the present day, and one, the Cordaitales, has been long extinct. All these classes, except Gnetales, contribute to the Permo-Carboniferous floras both of the Northern and Southern Hemispheres.

Class CORDAITALES.

An extinct race of seed-bearing, arborescent plants, with large, simple, entire leaves, traversed by simple, parallel or sub parallel nerves, with occasional dichotomy. The female fructification is a seed of the Gymnospermous type.

The best known genus of this group, *Cordaites*, is a characteristic member of the Permo-Carboniferous flora of the Northern Hemisphere. In the Glossopteris flora, the Cordaitales were probably represented by *Noeggerathiopsis*, but our knowledge of the habit, structure, and fructification of this plant is still very imperfect, and consequently this conclusion is to some extent provisional.

Genus NOEGGERATHIOPSIS, Feistmantel, 1879.

[Flora Gondw. Syst., vol. iii, pt. 1, p. 23.]

Leaves simple, spathulate, lanceolate or linear-lanceolate, or ovate. No midrib. Nervation sub-parallel, several parallel nerves entering the base of the leaf, dividing by dichotomy at a very acute angle, and without anastomosis.

Considerable difference of opinion has existed both with regard to the affinities of this genus, and also in respect to the identity of some of its members. The first Indian specimens were described by Bunbury in 1861, who referred them provisionally to the Gymnospermous genus *Noeggerathia*. This generic name was also at one time adopted by Feistmantel, but in 1879 he proposed a new genus *Noeggerathiopsis* for their reception, on the grounds that they were closely related to the Cycads. The same author, in 1881, pointed out the close similarity presented by the leaves described as *Rhiptozamites* by Schmalhausen [1] with the Indian and Australian species of *Noeggerathiopsis*, and the probable affinity of both these genera to the Mesozoic Cycads of the family Zamiæ.

In more recent times, Zeiller, Seward, Solms-Laubach,[2] and others have regarded this genus as in all probability a member of the Cordaitales, closely allied to *Cordaites*. Mr. Seward,[3] in fact, has recently expressed the view that "had the leaves referred to this genus been found in European Palæozoic rocks there can be little doubt that they would have been described under the name *Cordaites*."

Zeiller [4] has made a careful study of the leaves described by Schmalhausen as *Rhiptozamites*. He regards them as belonging

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[1] Schmalhausen (79).
[2] Solms-Laubach (91), p. 110.
[3] Seward (03[1]), p. 95.
[4] Zeiller (96[2]), p. 475; (02[1]), p. 32; (02[2]).

to a true *Cordaites*, and as distinct from the members of the Glossopteris flora described here, which, however, they closely resemble in several respects. Kurtz[1] has recently drawn attention to the more spreading type of nervation in the leaves occurring in the rocks of Gondwanaland.

Zeiller[2] has pointed out that the constant occurrence of Cordaitean seeds of the genera *Cardiocarpus* or *Cordaicarpus* in association with *N. Hislopi* is an additional argument in favour of referring *Noeggerathiopsis* to the Cordaitales.

On the whole, there seems to be a consensus of opinion at the present time that *Noeggerathiopsis* is probably best regarded as distinct from *Cordaites*, although closely allied to that genus. It is quite possible that the future may somewhat modify this view, as our knowledge of the genus is still very imperfect, little or nothing being known as to the habit of the plant, and there is an entire absence of any evidence as to the fructification.

Distribution.—Permo-Carboniferous (Glossopteris flora):—India, in the Talchir and Damuda divisions; New South Wales, in the "Lower Coal Measures" and Newcastle Series; Tasmania, Cape Colony, Transvaal, Argentina. *Triasso-Rhætic:*—?Tonquin, ?China.

1. Noeggerathiopsis Hislopi (Bunbury).

[Pl. VI, Figs. 2, 3; Pl. VIII, Fig. 2; Text-fig. 37.]

1847. *Zeugophyllites elongatus*, McCoy, Ann. & Mag. Nat. Hist., vol. xx, p. 152.
1849. *Noeggerathia spatulata*, Dana, in Wilkes' U.S. Explor. Exped., vol. x, p. 715, pl. xii, fig. 9.
N. media, Dana, ibid., p. 715, pl. xii, fig. 10.
N. elongata, Dana, ibid., p. 715.
1850. *Zeugophyllites elongatus*, Unger, Gen. et Spec. Plant. foss., p. 332.
1861. *Noeggerathia? (Cyclopteris?) Hislopii*, Bunbury, Quart. Journ. Geol. Soc., vol. xvii, p. 334, pl. x, fig. 5.
1872. *N. Goepperti*, Schimper, Traité, vol. ii, p. 130.
1878. *N. spathulata*, Feistmantel, Palæontogr., Suppl. iii, p. 97.
N. media, Feistmantel, ibid., p. 97.
? *N. prisca*, Feistmantel, ibid., p. 158, pl. viii (xxvi), fig. 3.

[1] Kurtz (03), p. 25.

[2] Zeiller (02^1), p. 32.

1879. *Noeggerathiopsis Hislopi*, Feistmantel, Flora Gondw. Syst., vol. iii, pt. 1, p. 23, pl. xix, figs. 1–6; pl. xx, figs. 1, 1*a*.
N. Hislopi, var. *subrhomboidalis*, Feistmantel, ibid., p. 24, pl. xx, fig. 2.
1881. *N. Hislopi*, Feistmantel, ibid., vol. iii, pts. 2, 3, p. 118, pl. xlv A, figs. 1–11; pl. xlvi A, figs. 3, 4.
N. Hislopi, Feistmantel, ibid., vol. iii, pt. 1, Suppl., p. 58, pl. xxviii, figs. 1–4, 6–7; pl. xxix, figs. 1–4; pl. xxx, figs. 5–9.
1882. *N. Hislopi*, Feistmantel, ibid., vol. iv, pt. 1, p. 41, pl. ix, figs. 1–3; pl. xiii, figs. 2–4; pl. xiv, figs. 1–3, 6, 9; pl. xv, fig. 4*b*; pl. xvii, fig. 4; pl. xviii, fig. 1; pl. xx, fig. 10; pl. xxi, figs. 6, 8, 10.
1883. *N. media*, Tenison-Woods, Proc. Linn. Soc. New South Wales, vol. viii, p. 154.
N. spathulata, Tenison-Woods, ibid., p. 153.
N. elongata, Tenison-Woods, ibid., p. 154.
? *N. prisca*, Tenison-Woods, ibid., p. 154.
1886. *N. Hislopi*, Feistmantel, Flora Gondw. Syst., vol. iv, pt. 2, p. 40, pl. xii A, fig. 5*a*; pl. xiii A, fig. 5.
N. spathulata, Johnston, Papers and Proc. R. Soc. Tasmania for 1885, p. 386.
N. media, Johnston, ibid., p. 386.
N. elongata, Johnston, ibid., p. 386.
? *N. prisca*, Johnston, ibid., p. 386.
1888. *N. spatulata*, Johnston, Geol. Tasmania, p. 111, pl. x, figs. 2, 3.
N. media, Johnston, ibid., p. 111, pl. ix, figs. 2–4.
? *N. prisca*, Johnston, ibid., p. 111.
1889. *N. Hislopi*, Feistmantel, Abhand. böhm. Gesell. Wiss. Prag, ser. VII, vol. iii, p. 38, pl. iv, fig. 1.
1890. *N. Hislopi*, Feistmantel, Mem. Geol. Surv. New South Wales, Pal., No. 3, p. 153.
N. spathulata, Feistmantel, ibid., p. 154.
N. media, Feistmantel, ibid., p. 154, pl. xxi, figs. 3–5.
? *N. prisca*, Feistmantel, ibid., p. 155, pl. xiii, fig. 2.
1893. *N. elongata*, Etheridge, jun., Rec. Geol. Surv. New South Wales, vol. iii, pt. 3, p. 75.
N. Hislopi, Oldham, Man. Geol. India, p. 162, pl. opp. p. 158.
1894. *N. Hislopi*, Kurtz, Rev. Mus. La Plata, vol. vi, p. 131, pl. iii, figs. 3, 4; pl. iv, fig. 1.
N. Hislopi, var. *subrhomboidalis*, Kurtz, ibid., p. 132, pl. iv, fig. 2.
1895. *N. Hislopi*, Bodenbender, ibid., vol. vii, table opposite p. 148.
1896. *N. Hislopi*, Bodenbender, Zeitschr. deutsch. geol. Gesell., vol. xlviii, table opposite p. 772.
N. Hislopi, Zeiller, Bull. Soc. Géol. France, ser. III, vol. xxiv, p. 372, text-figs. 16, 17; pl. xviii, figs. 6–9.
1897. *N. Hislopi*, Seward, Quart. Journ. Geol. Soc., vol. liii, p. 322, pl. xxi, fig. 4*b*.
1898. *N. Hislopi*, Seward, ibid., vol. liv, p. 93.
1900. ? *N. Hislopi*, Potonié, in Deutsch-Ost-Afrika, vol. vii, p. 501.

1902. *Noeggerathiopsis Goepperti*, Arber, Quart. Journ. Geol. Soc., vol. lviii, p. 17, pl. i, figs. 1, 2.

? *N. Hislopi*, Zeiller, Flore Foss. Gîtes Charb. Tonkin, p. 149, pl. xl, figs. 1–6, ? 7–9.

1903. *N. Hislopi*, Seward, Ann. S. African Mus., vol. iv, pt. 1, p. 96, pl. x, fig. 5; pl. xiii, figs. 2–4.

N. Hislopi, Kurtz, Quart. Journ. Geol. Soc., vol. lix, p. 25.

Type. No. R. 10,370, Mus. Geol. Soc. London.

Leaves considerably varied both in shape and size, broadly linear, oval-linear, sub-linear, spathulate, or obovate. Apex obtusely rounded. Lamina contracted at the base. Nerves numerous, somewhat strong, fairly distant, sub-parallel, branching dichotomously at a very acute angle, especially in the basal portion and occasionally in other parts of the leaf. Fine and close longitudinal striations occur between the nerves on the upper surface of the leaf. The epidermal cells have rectilinear walls, and fine punctures, indicating stomata, occur on the lower surface.

The size of the leaf varies greatly, from 8–23 cm. or more in length, and from 1–5 cm. across at the broadest part. The nerves are strong (·2–·3 mm. broad), and are distant about ·25–·75 mm. In some cases, as Feistmantel pointed out, the leaf is slightly unsymmetrical.

Feistmantel [1] has described a variety which he named *N. Hislopi*, var. *subrhomboidalis* (Text-fig. 37B), in which the leaf is rather wider than usual in the upper portion and somewhat narrower towards the base; but in view of the great variety in shape and size presented by these leaves, this form seems to me to be hardly worthy of distinction.

The leaf named by Kurtz,[2] *Sphenozamites multinervis*, appears to be probably a young or small leaf of a *Noeggerathiopsis* (cf. Feistmantel (79¹), pl. xix, figs. 3–5), and I do not see any good evidence for assuming that it represents a Cycadean frond.

A leaf from the older *Glossopteris*-bearing rocks of New South Wales, at Greta, described by Feistmantel [3] as *Noeggerathiopsis prisca*, hardly appears to me to be distinct from *N. Hislopi*. In nervation it may be compared with the specimen figured here on Pl. VIII, Fig. 2, from India.

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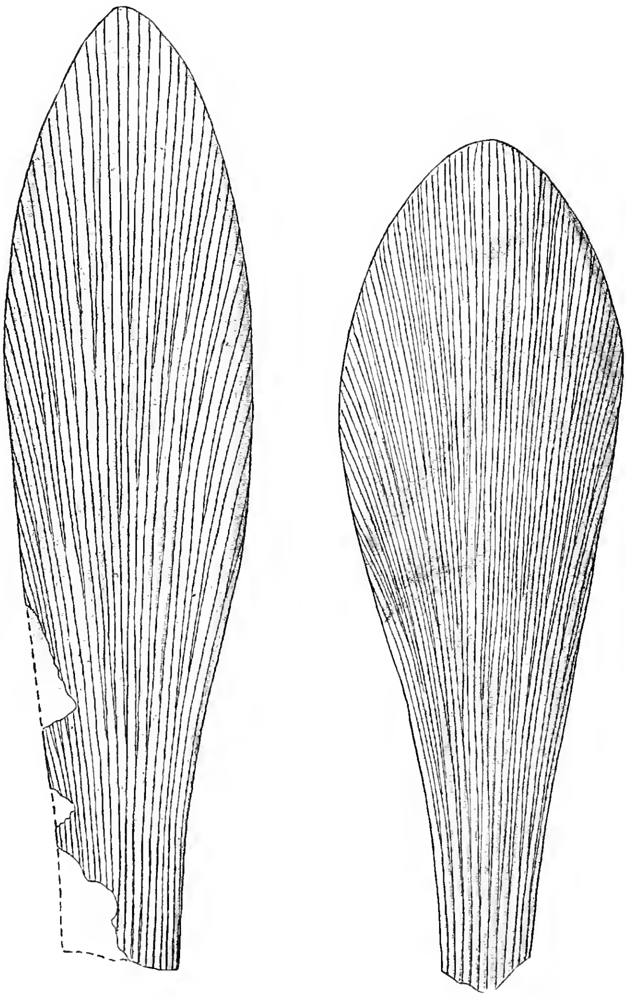
[1] Feistmantel (79¹), p. 24, pl. xx, fig. 2.

[2] Kurtz (94²), p. 130, pl. iii, fig. 2.

[3] Feistmantel (90), p. 155, pl. xiii, fig. 2.

A good deal of confusion has arisen with regard to some Australian leaves, similar to the Indian species *Noeggerathiopsis*



A *B*

Fig. 37.—*Noeggerathiopsis Hislopi* (Bunb.). After Feistmantel. Nat. size.

Hislopi, which were first described by McCoy in 1847. McCoy[1] referred them to a Triassic species instituted by Morris as *Zeugophyllites elongatus*, which has been transferred recently by Mr. Seward[2] to the genus *Phœnicopsis* of Heer. It was not until 1892 that Mr. Etheridge, jun., pointed out that McCoy's determination was incorrect. McCoy's specimens were redescribed[3] in 1902, when I referred the leaves in question to *Noeggerathiopsis Goepperti*, a species described by Schmalhausen[4] from the Permian rocks of Russia. A full account of the confusion with regard to McCoy's plant will be found in that paper. At that time, as I stated, I was unable to arrive at a definite conclusion with regard to the identity of *N. Goepperti* with *N. Hislopi*, despite their great similarity in habit and detail. I am now, however, of opinion that the Australia fronds should be referred to *N. Hislopi*, since such differences as exist seem to be insufficient to warrant separation. Zeiller has shown that Schmalhausen's species must now be transferred to *Cordaites*, and that *Noeggerathiopsis* is probably not identical with that genus.

It appears to me that all the three species instituted by Dana[5] in 1849 are identical with *N. Hislopi*. Feistmantel[6] has already united two of the leaves in question.

The plant recently figured by Shirley[7] as *Noeggerathia* (?), sp., is of very uncertain affinity. The leaf doubtfully ascribed to the genus *Noeggerathiopsis* by Seward[8] is rather like some of the Indian and Australian species described by Feistmantel. The same author[9] has recently expressed doubt whether the Tonquin specimens referred to this species by Zeiller may not be identical with *Phœnicopsis elongata* (Morris).

Distribution.—Permo-Carboniferous (Glossopteris flora):—India, in the Talchir and Damuda divisions; New South Wales, in the "Lower Coal Measures" and Newcastle Series; Tasmania, Cape Colony, Transvaal, Argentina. *Triasso-Rhætic*:—? Tonquin, ? China.

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[1] McCoy (47), p. 152.
[2] Seward (03^1), p. 67.
[3] Arber (02^1), p. 17.
[4] Schmalhausen (79).
[5] Dana (49), p. 715, and pl. xii, figs. 9, 10.
[6] Feistmantel (90), p. 154.
[7] Shirley (02), p. 8, pl. iv.
[8] Seward (04), p. 100, pl. iv, fig. 8.
[9] Seward (03^1), p. 96.

Specimens of Noeggerathiopsis Hislopi from India.

V. 7233. Pl. VIII, Fig. 2.

This specimen shows two leaves, of which the one figured on Pl. VIII, Fig. 2, is nearly perfect. It is obovate, contracted at the base, and broadly rounded at the apex. It measures 4·6 cm. long, and 3·2 cm. broad at its greatest width. At the base the nerves are few in number, but they dichotomise above. The veins are rather coarse. The other specimen is a rather imperfect basal portion, showing the nervation clearly.

Silewáda, near Nágpur.

V. 7131. A median portion of a leaf, without base or apex, measuring 5·3 cm. long and 2·3 cm. broad. The parallel nerves are well marked, distant, slightly spreading from the base, and forking in the distal portion of the leaf.

Kamthi. *Hunter Coll.*

V. 4207. Among a number of fronds on this specimen, most of which belong to the genus *Glossopteris*, there are one or two fragments of narrow leaves with sub-parallel veins, and a much broader leaf, in which the veins are strong and forked.

? India.

Specimens of Noeggerathiopsis Hislopi from Tasmania.

V. 3776*w*. Pl. VI, Fig. 2.

A portion of a broadly oval or spathulate leaf, 12·5 cm. long, and more than 4·5 cm. across. The nerves are rather close, for the most part sub-parallel, but rather spreading and arched towards the margin, and dichotomising occasionally, especially near the base of the leaf.

Mersey River. *Pres. by T. Stephens, Esq.*, 1898.

V. 3776*y*. Pl. VI, Fig. 3.

A basal portion of a strap-shaped leaf, 8 cm. long. At the narrow base there are only about six or eight veins, which, however, dichotomise at a higher level. This leaf is apparently indistinguishable, except in size and shape, from the much broader leaves, such as that figured on Pl. VI, Fig. 2, or from the other fragmentary portions also occurring on this specimen. Several fronds of *Glossopteris*, and a small seed are also associated.

Mersey River. *Pres. by T. Stephens, Esq.*, 1898.

V. 3776*v*. A strap-shaped leaf, almost linear in the upper portion, but contracting slightly at the base. It measures 6·7 cm. long, and 1·4 cm. across at its greatest breadth. It is associated with fronds of *Glossopteris*.

Mersey River. *Pres. by T. Stephens, Esq.*, 1898.

V. 3776*ab*. A felted mass of leaves, among which are a few fragments belonging to *N. Hislopi*, showing the sub-parallel nervation clearly.

Mersey River. *Pres. by T. Stephens, Esq.*, 1898.

V. 3776*aa*. A small portion of an oblong leaf with sub-parallel veins, associated with *Glossopteris* and *Cardiocarpus*.

Mersey River. *Pres. by T. Stephens, Esq.*, 1898.

V. 3776*x*. Several fronds of *Glossopteris*, with which occurs a fragment of an oblong leaf, in which the veins are fairly distant from one another.

Mersey River. *Pres. by T. Stephens, Esq.*, 1898.

V. 3776*ad*. A felted mass of fragments of leaves belonging to this species, in some of which the nervation is fairly clear.

Mersey River. *Pres. by T. Stephens, Esq.*, 1898.

V. 3776*ae*. This specimen shows portions of two leaves, associated with *Glossopteris Browniana* and *Glossopteris ampla*. One of these measures 8 cm. in length, and has fairly distant nerves, but the nervation is not very well seen.

Mersey River. *Pres. by T. Stephens, Esq.*, 1898.

Other specimens:—**V. 3776***z*, **V. 3776***ac*, **V. 3776***af*, **V. 3776***ag*, **V. 3776***ah* (Mersey River; *pres. by T. Stephens, Esq.*, 1898). *Noeggerathiopsis*, sp., **40,942** (Newcastle Coalfield, New South Wales; *pres. by Sir E. Home*, 1857).

Specimens of Noeggerathiopsis Hislopi from South Africa.

? V. 3625. Figured by Seward (97[1]), p. 322, pl. xxi, fig. 6.

A small fragment 2·5 cm. long, with rather indistinct, almost parallel veins. The surface is strongly convex.

Boschmans Fontein, Middelburg, Transvaal.

Pres. by D. Draper, Esq., 1897.

V. 3613. Figured by Seward (97[1]), p. 322, pl. xxi, fig. 4*b*.

A basal portion of a leaf, about 5 cm. long, associated with a frond of *Glossopteris angustifolia*.

Casey's Township, Transvaal. *Pres. by D. Draper, Esq.*, 1897.

V. 8323. Described by Seward (92[2]), p. 93.

A piece of white sandstone, with a basal portion of a long leaf, 20 cm. in length, and nearly 5 cm. across. The nervation is not very clear, but the nerves do not appear to anastomose, and are nearly parallel. The leaf is markedly constricted towards the base. Fragments of fronds of *Glossopteris* are also associated.

Vereeniging, Transvaal. *Pres. by Dr. F. H. Hatch*, 1898.

2. Noeggerathiopsis Whittiana (Feistmantel).

1879. *Euryphyllum Whittianum*, Feistmantel, Flora Gondw. Syst., vol. iii, pt. 1, p. 26, pl. xxi, figs. 1, 1*a*.
1881. *E. Whittianum*, Feistmantel, ibid., vol. iii, pt. 3, p. 120.
1894. *Noeggerathiopsis Hislopi*, var. *euryphylloides*, Kurtz, Rev. Mus. La Plata, vol. vi, p. 132, pl. iv, fig. 3.
1896. *Euryphyllum Whittianum* (?), Bodenbender, Zeitschr. deutsch. geol. Gesell., vol. xlviii, table opposite p. 772.

Type. No. 5036, Mus. Geol. Surv. India, Calcutta.

Leaves ovate-spathulate, rounded at the apex, gradually contracted at the base, unsymmetrical. Nerves strong, radiating from the base at a very acute angle, with frequent dichotomy, those of the median portion of the leaf sub-parallel, those in the lateral portions arched towards the margin.

The figures given by Feistmantel of these leaves from the Karharbári Group in India recall some of the broader forms of *Noeggerathiopsis Hislopi* (cf. with Feistmantel (79[1]), pl. xx, fig. 2) in shape and general nervation. They apparently differ only in the larger size, broader outline, and in the nervation being less nearly parallel, more arched, and more subdivided. These differences in the nervation, however, may be very well accounted for by the larger size of the leaf. Feistmantel placed them in a new genus *Euryphyllum* on the grounds that they were borne spirally on a broad axis, which he figures. He, however, admits (explanation to his figure (79[1]), pl. xxi, fig. 1) that there is no real evidence of continuity between the leaves and the axis. It seems to me safer for the present to conclude that these leaves belong to the genus *Noeggerathiopsis*, and to compare them with *N. Hislopi*, which they so closely resemble in habit.

Zeiller[1] has recently pointed out that this species is also, in all probability, a member of the group Cordaitales.

The leaf from Argentina, named by Kurtz[2] *Noeggerathiopsis Hislopi*, var. *euryphylloides*, appears to be a basal portion of a frond of this type.

N. Whittiana is known from the Karharbári Series in India, and from Argentina.

Not represented in the British Museum collection.

3. Noeggerathiopsis (?) Stoliczkana (Feistmantel).

(Text-fig. 38.)

1876. *Glossozamites Stoliczkanus*, Feistmantel, Rec. Geol. Surv. India, vol. ix, pt. 4, p. 142.

1879. *G. Stoliczkanus*, Feistmantel, Flora Gondw. Syst., vol. iii, pt. 1, p. 19, pl. xx, figs. 4, 5.

1881. *G. Stoliczkanus*, Feistmantel, ibid., vol. iii, pt. 3, p. 117.

Type. Nos. 5034–5, Mus. Geol. Surv. India, Calcutta.

Leaf simple (?), oblong, slightly unsymmetrical. Apex broadly rounded. Base truncated, broad, lateral angles slightly rounded. Nerves somewhat radiating in the basal portion, becoming very erect, sub-parallel, and dichotomising once or twice at a very acute angle.

Feistmantel has figured as *Glossozamites Stoliczkanus* a single specimen of a leaf from the Karharbári Beds in India, which he regarded as a pinnule of a Cycadean frond, and not as a member of the genus *Noeggerathiopsis*. This conclusion was founded on the nature of the broad, truncated base, which he interpreted as evidence of insertion on a rachis in a similar manner to the pinnules of the Cycadean fronds of Mesozoic age included in Schimper's genus *Glossozamites*. There is no reliable evidence, however, as to the mode of attachment, and it seems to me impossible to overlook the great similarity which this leaf presents to *Noeggerathiopsis Hislopi*, both in its nervation and the general habit other than the characters of the basal portion. In the case of *N. Hislopi* also the mode of attachment is unknown. Thus, on the present evidence, it would seem to me safer provisionally to

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[1] Zeiller (02), p. 38.

[2] Kurtz (94^2), p. 132, pl. iv, fig. 3.

refer Feistmantel's specimen to that genus, on the grounds that it possesses several characters in common with *N. Hislopi*. It is possible that the discovery of further examples may prove that Feistmantel was right in his conclusion, but at present there seems to be little or no trustworthy evidence as to the Cycadean nature of this species.

Not represented in the British Museum collection.

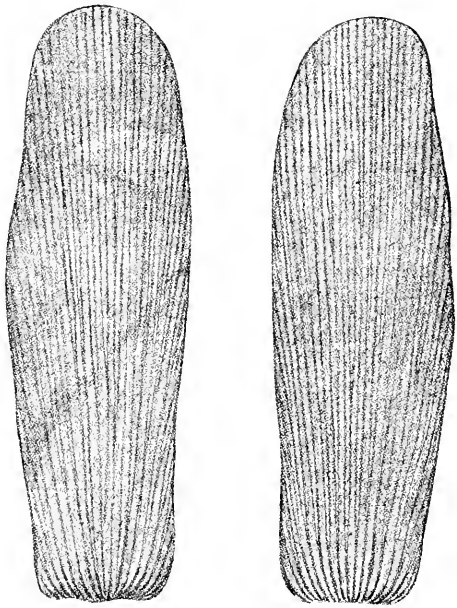

Fig. 38.—*Noeggerathiopsis* (?) *Stoliczkana* (Feist.). After Feistmantel. Nat. size.

4. [Noeggerathiopsis ?] lacerata, Feistmantel.

(Text-fig. 39.)

1882. *Noeggerathiopsis lacerata*, Feistmantel, Flora Gondw. Syst., vol. iv, pt. 1, p. 42, pl. xv, figs. 1–3, 4*a*; pl. xvii, figs. 2, 3.

1902. *N.* (?) *lacerata*, Zeiller, Pal. Indica, N.S., vol. ii, p. 32, pl. vii, figs. 2, 3.

Type. Nos. 5455–7 and 5472, Mus. Geol. Surv. India, Calcutta.

Leaf rather small, broadly spathulate, deeply lobed at the apex.

Lobes linear, acuminate. Nerves strong, radiating from the base, dichotomous. Leaf apparently pleated.

Zeiller has recently pointed out that it is very doubtful if this fossil should be included in the genus *Noeggerathiopsis*, and in this conclusion I agree. I have, therefore, enclosed the generic name in square brackets to indicate that this species should be transferred to some other genus, but, not having seen any specimens of this plant, I am unable to suggest any change at present.

Feistmantel regarded these leaves as pinnules of a pinnate frond, but there is apparently no real evidence in favour of this conclusion. They differ markedly from *N. Hislopi*, both in the divided apical

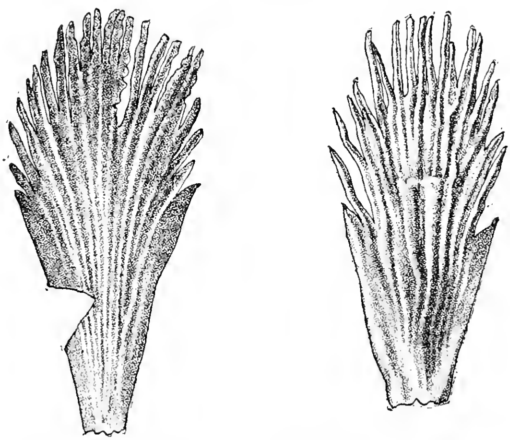

Fig. 39.—[*Noeggerathiopsis?*] *lacerata*, Feist. After Feistmantel. Nat. size.

portion and also in the nervation. Zeiller has suggested that they may be more closely compared with certain members of the class Ginkgoales, such as *Ginkgo*, *Ginkgodium*, and *Whittleseya*.

This species is known only from the Karharbári and Raniganj Groups in India.

Not represented in the British Museum collection.

Leaf of Doubtful Affinity from S. Africa.

V. 3614. Figured by Seward (97[1]), p. 333, pl. xxi, fig. 5.

This specimen shows a strongly convex leaf, 3·8 cm. long, and 7 mm. broad. The apex ends in a sharp, narrow point. The base

is not well preserved. It is traversed by a number of parallel veins. It is impossible to refer this fragment to any genus. The closest comparison is with the Gymnosperms, as Mr. Seward has pointed out.

Casey's Township, Transvaal. *Pres. by D. Draper, Esq.*, 1897.

Genus **DADOXYLON**, Endlicher, 1847.

(Synop. Conifer., p. 298.)

Endlicher defined this genus thus: — "Truncus cylindricus, e medulla centrali, et ligni stratis concentricis obsoletis aut rarius distinctis et e cortice compositus. Vasa (ligni cellulæ prosenchymatosæ) porosa, poris in series 1–4 spiraliter dispositis, quam maxime approximatis, demum ob mutuam pressionem sex-angularibus, plerumque nonnisi in parietibus radiis medullaribus parallelis, et invicem oppositis obviis. Radii medullares e cellularum parenchymatosarum serie unica v. pluribus formati, simplices v. compositi."

This genus is now, however, used in a restricted sense, and the following may be regarded as its chief characters:—Petrified wood of Palæozoic age of the Coniferous type, closely similar to that of the modern Araucariæ. Rings of growth usually well marked. Xylem centrifugally developed, tracheides as a rule pitted only on the radial walls. Bordered pits, hexagonal in outline, usually contiguous, pluriseriate, more rarely distant and uni- or biseriate. Pith usually large, fistular or solid. Cortex as a rule without gum-canals or resin-cells, but the latter are sometimes found in the cortex, wood, and pith.

In both Palæozoic and Mesozoic rocks petrified woods of the Araucarian type occur, whose precise affinities it is often difficult or impossible to determine. The term *Araucarioxylon*, Kraus, was at one time[1] applied to such specimens, whether of Palæozoic or Mesozoic age, but it has been recently decided that this name should be restricted to woods of the latter age.[2] The old genus *Dadoxylon* has been revived, and to it the Palæozoic specimens are

[1] Schimper (69), vol. ii, p. 380.
[2] Zeiller (00[1]), p. 280; Knowlton (90), p. 606; Scott (02), p. 331.

now referred. Some woods of this type have proved to belong to *Cordaites*, while in the great majority of cases there is no evidence as to the precise affinity of such specimens.

It would seem probable that some of the Australian woods described here may belong to *Noeggerathiopsis*, but at present there is no definite evidence that this is the case.

1. **Dadoxylon australe,** sp. nov.

(Text-figs. 40–43.)

Nicol[1] figured, in 1833, some transverse sections of petrified woods from Australia. There are several similar sections in the British Museum collection, most of which are obviously of the same type, and these I propose to describe as *Dadoxylon australe*, since Nicol did not give any name to his specimens.

Co-types.—Transverse sections, **51,479** (Australia), **51,434** (Newcastle). Radial sections, **51,616** (Australia), **51,476** (Newcastle). Tangential sections, **51,503** (Australia), **51,461** (Newcastle). Trans., Rad., and Tang. sections, **V. 8299** (Australia).

Pith not preserved. Xylem with well-marked rings of growth, each as a rule between 3·5 and 8·5 mm. in radius. Sometimes the growth is irregular. The 'spring wood' graduates imperceptibly into the denser 'autumn wood.' Xylem comparatively dense, apparently entirely centrifugal. Tracheides, in transverse section, very small, narrow, square, or slightly oblong, with rounded angles, about 25 in a millimetre of length. Tracheides short, with hexagonal bordered pits only on the radial walls. Usually these pits are multiseriate and crowded, but not infrequently they are found to be uni- or biseriate, distant or few. Medullary rays extremely numerous, uniseriate, very rarely two cells thick, usually 6–12 or more cells in height.

The medullary ray cells communicate with the tracheides by 2–6 simple, oblique pits. Cortex absent.

It has not been found possible to identify the actual specimens figured by Nicol, but they are probably among those mentioned here. In describing this species, difficulty has arisen from the fact

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[1] Nicol (33), pl. iii, figs. 1–3.

that not only is there no complete section showing the cortex, wood, and pith in the collection, but it is impossible to say which transverse and longitudinal sections of the wood were originally cut from the same specimen. However, the great majority are undoubtedly identical specifically, and I have therefore chosen two of the best sections cut in each direction as co-types together with

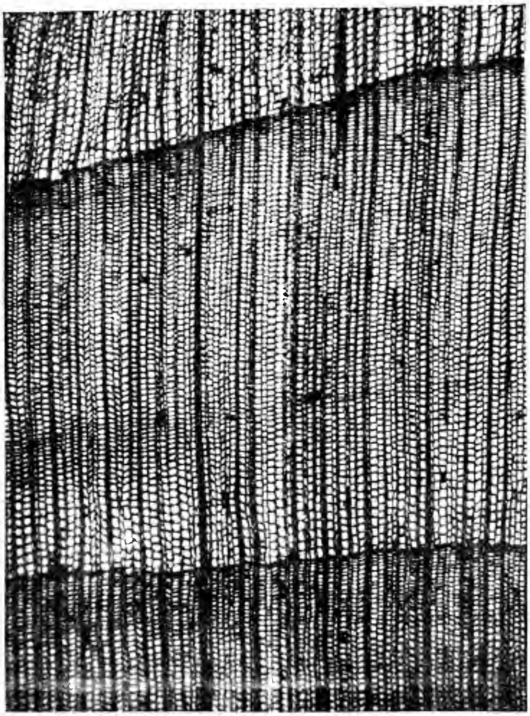

FIG. 40.—*Dadoxylon australe*, sp. nov. Transverse section. 51,479. × 25.

No. V. 8299, which has three sections on one slide, and thus shows that the longitudinal sections described here belong to the same species of stem as those cut in a transverse direction. The special characteristics of this species are the small and short tracheides, and the numerous medullary rays.

The great majority of Nicol's sections are from Newcastle. In a collection which Mr. A. G. Hamilton, of Willoughby, New South Wales, very kindly placed in my hands for examination, I have recognised several sections from Avondale, Mount Kembla, Mount Keira, and Bellambi, all in the Illawarra district, as probably identical with this species.

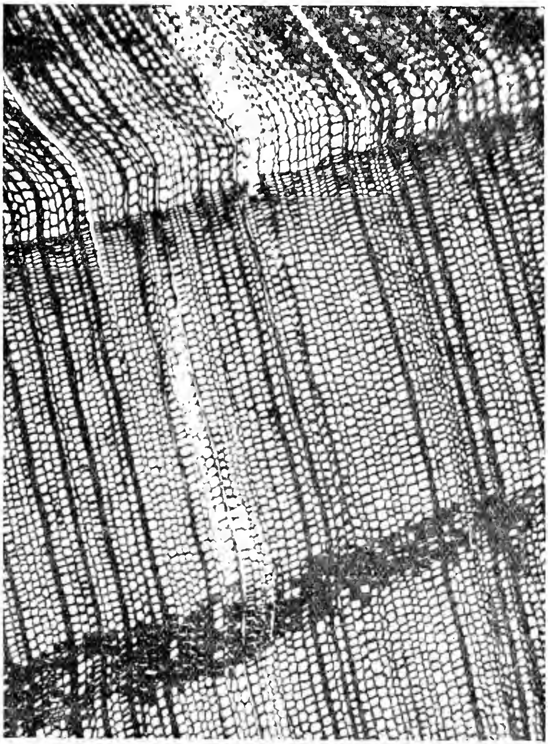

FIG. 41.—*Dadoxylon australe*, sp. nov. Transverse section. V. 8299. × 30.

Mr. Hamilton informs me that petrified wood is very common in the Newcastle Series of New South Wales, especially in the Illawarra district, in association with *Glossopteris*. Large trunks of trees have been found at Mount Kembla, and elsewhere stumps and trunks, as well as smaller fragments, are common. As far back

as 1843 the Rev. W. B. Clarke[1] gave some account of the fossil wood occurring in abundance at Lake Macquarie, New South Wales, and some of Nicol's sections, figured in 1833, came from the same locality.

Schenk[2] has also described, under the name *Araucarioxylon Felixianum*, some woods from Queensland and Kiami in New

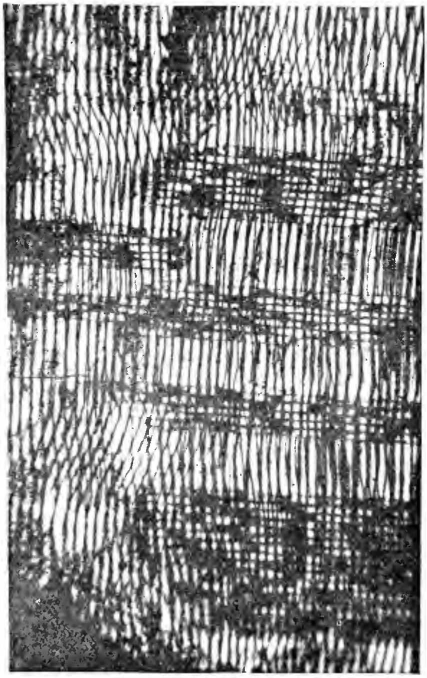

FIG. 42.—*Dadoxylon australe*, sp. nov Radial longitudinal section. 51,616. × 35.

South Wales, in the botanical collection at Leipzig. From his brief description these do not appear to be identical with the present species.

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[1] Clarke (13). [2] Schenk in Zittel, p. 870.

Carruthers[1] mentioned petrified wood from Jack's Creek, Queensland, but did not give any description. His name *Araucarioxylon Nicoli* is a *nomen nudum*. Jack & Etheridge[2] also pointed out the common occurrence of fossil wood on certain horizons in the Bowen Series.

51,479. Text-fig. 40. Co-type.

Trans. Sect. A large and good section, showing several rings of growth, of which a part is reproduced from a microphotograph in Text-fig. 40, enlarged 25 times. This figure shows the small size of the tracheides, and the numerous medullary rays; also the gradual transition from the larger elements of the 'spring wood' to the denser and smaller 'autumn' tracheides.

Australia. *Nicol Coll.*

51,434. Co-type. *Trans. Sect.* A rather smaller section than the previous specimen, but identical in every respect. The rings of growth are clearly seen. They are sometimes irregular, as Nicol noticed in his description of similar sections; false rings of varying outline occur, which are due to bad preservation.

Newcastle, New South Wales. *Nicol Coll.*

51,616. Text-fig. 42. Co-type.

Rad. Long. Sect. A well-preserved section, a small portion of which is figured enlarged 35 times in Text-fig. 42. It shows the numerous medullary rays and the pitted tracheides.

Australia. *Nicol Coll.*

51,476. Co-type. *Rad. Long. Sect.* A section similar to the last, but not quite so thin. The large number of the medullary rays and the short tracheides are well seen. The bordered pits, often only uni- or biseriate, can here and there be distinguished.

Bottom of the cliff, Newcastle, New South Wales. *Nicol Coll.*

51,503. Text-fig. 43. Co-type.

Tang. Long. Sect. A small portion of this section is reproduced from a microphotograph enlarged 35 times in Text-fig. 43. The numerous medullary ray cells, only one cell thick, are seen. The absence of bordered pits on the tangential walls of the tracheides is noticeable.

Australia. *Nicol Coll.*

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[1] Carruthers (80), p. 328.

[2] Jack & Etheridge (92), p. 198.

51,461. Co-type. *Tang. Long. Sect.* A tangential section similar to 51,503, showing the medullary rays and tracheides.

Bottom of the cliff, Newcastle, New South Wales. *Nicol Coll.*

V. 8299. Text-fig. 41. Co-type.

Trans., Rad., and Tang. Long. Sections. These sections, all mounted on one slide, are precisely identical in structure with

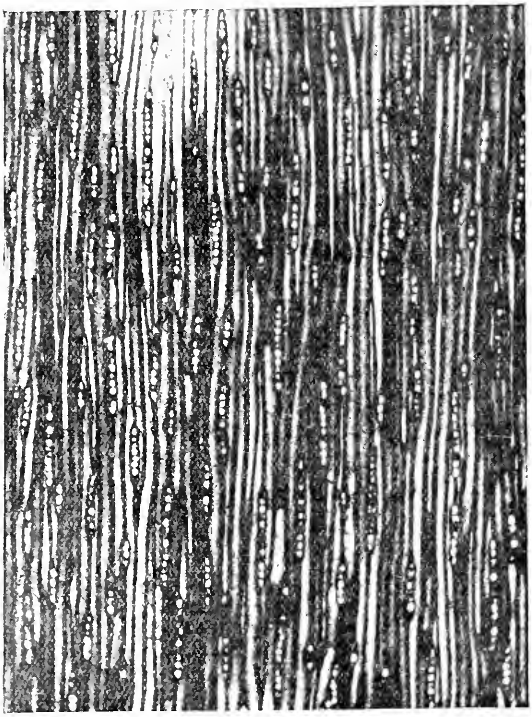

Fig. 43.—*Dadoxylon australe*, sp. nov. Tangential longitudinal section. 51,503. × 35.

the specimens above described. There is every reason to believe that all three were cut from the same specimen, but in different directions.

The transverse section is very thin, and is particularly well preserved, a portion of three rings of growth being seen. Part of

this section is figured in Text-fig. 41, enlarged 30 times. Among the xylem elements a number of cells with brown contents are found, sometimes forming a well-marked ring, at other times more scattered. These are possibly secretory cells. In the radial section, the short tracheides with bordered pits, and the numerous medullary rays are very clear. This is also the case in the tangential section, where, however, pits are absent from the walls of the tracheides.

Australia (? near Newcastle).

51,475. *Trans. Sect.* A section precisely similar to sections 51,479 and 51,434. The rings of growth are apparently irregular, owing to bad preservation along certain lines.

Bottom of the cliff, Newcastle, New South Wales. *Nicol Coll.*

51,455. *Tang. Long. Sect.* A section similar to 51,503 and 51,461, but not so well preserved. The section in part is nearly radial.

Newcastle, New South Wales. *Nicol Coll.*

51,445. *Rad. Long. Sect.* A radial section similar to 51,616 and 51,476, but not so thin.

Newcastle, New South Wales. *Nicol Coll.*

51,423. *Trans. Sect.* A good section showing the medullary rays and well-marked rings of growth.

Australia. *Nicol Coll.*

51,432. *Trans. Sect.* A section, probably of this species, 4 3 cm. long, but only showing one ring of growth. The medullary rays are well marked.

Scaffold Hill Quarry, near Newcastle, New South Wales. *Nicol Coll.*

51,446. *Trans. Sect.* The square tracheides, the medullary rays, and the rings of growth are seen in this section.

Australia. *Nicol Coll.*

51,459. *Trans. Sect.* A badly preserved, crushed, and distorted stem, possibly of this species.

Lake Macquarie, New South Wales. *Nicol Coll.*

51,462. *Rad. Long. Sect.* A well-preserved section, showing the tracheides with multiseriate bordered pits, and the medullary rays, usually 6–9 cells in height, very numerous, or almost crowded.

Australia. *Nicol Coll.*

51,467. *Rad. Long. Sect.* Not very well preserved, but showing the numerous medullary rays.

Scaffold Hill, near Newcastle, New South Wales. *Nicol Coll.*

51,470. *Rad. Long. Sect.* A good section, in which the multiseriate bordered pits are seen here and there.

New South Wales. *Nicol Coll.*

51,474. *Trans. Sect.* A fairly well-preserved section, showing the small, almost square tracheides, numerous medullary rays, and well-marked rings of growth.

Australia. *Nicol Coll.*

51,478. *Rad. Long. Sect.* This section may possibly have been derived from the same petrifaction as section 51,475. It shows the bordered pits and medullary rays clearly.

Bottom of cliff, near Newcastle, New South Wales. *Nicol Coll.*

51,502. *Trans. Sect.* A well-preserved section, possibly derived from the same petrifaction as section 51,479 (co-type).

Australia. *Nicol Coll.*

51,505. *Trans. Sect.* A fairly good section, showing the medullary rays and rings of growth.

Australia. *Nicol Coll.*

51,617. *Tang. Long. Sect.* A good tangential section, possibly derived from the same petrifaction as section 51,616 (co-type).

Australia. *Nicol Coll.*

V. 8238. *Trans., Rad., and Tang. Long. Sects.* A good series of sections in three directions, showing the structure of the tracheides and medullary rays. The radial section resembles section 51,616 (co-type).

Australia.

V. 8287. *Trans. Sect.* A fairly good section, showing the medullary rays and rings of growth.

New South Wales.

51,471. *Trans. Sect.* A rather crushed stem, but the structure is fairly clear in places.

Australia. *Nicol Coll.*

51,504. *Rad. Long. Sect.* Not well preserved, but the medullary rays are fairly clear, and the pits on the tracheides can be seen here and there.

Australia. *Nicol Coll.*

51,729. *Trans. Sect.* A good section, showing the rings of growth, medullary rays, and small tracheides.
Australia. *Nicol Coll.*

51,794. *Rad. Long. Sect.* The medullary rays and multiseriate bordered pits are well seen in this section.
Bottom of cliff, near Newcastle, New South Wales. *Nicol Coll.*

Some of the following indifferently preserved sections may belong to *Dadoxylon australe*, while others perhaps to a different species.

Other sections:—Transverse. **51,419** (Australia), **51,435** (Newcastle, New South Wales), **51,436** (Newcastle), **51,457** (Newcastle), **51,460** (bed of Hunter River, New South Wales), **51,459** and **51,464** (Lake Macquarie, New South Wales), **51,468** (Newcastle), **51,469** (New South Wales), **51,477** (bottom of cliff, near Newcastle), **51,501** (Newcastle), **51,545** (26 miles north-west of Newcastle), **51,615** (Lake Macquarie), **51,655** and **51,657** (Telegraph Hill, Newcastle), **51,683** (bottom of cliff, near Newcastle), **51,686**, **51,692**, and **51,708** (Newcastle), **51,755** and **51,768** (Wollongong).

Rad. Long. Sects. **51,472** (New South Wales), **51,525** (Australia).

Tang. Long. Sects. **51,918** and **51,919** (Sydney, New South Wales).

All the above in the *Nicol Coll.*

Trans. Sects. **V. 8286** (Lake Macquarie), **V. 8289** (Hunter River), **V. 8291** (Botany Bay), **V. 8300** (Australia).

Tang. Long. Sects. **V. 8288** (Hunter River), **V. 8290** (New South Wales).

All the above in the *General Collection of Sections.*

2. Dadoxylon Pedroi, Zeiller.

1895. *Dadoxylon Pedroi*, Zeiller, Bull. Soc. Géol. France, ser. III, vol. xxiii, p. 619, pl. ix, fig. 4, and text-figs. 8–19.
D. Pedroi, Zeiller, Compt. Rend., vol. cxxi, p. 964.
1902. *D. Pedroi*, Scott, Trans. Roy. Soc. Edinb., vol. xl, pt. 2, p. 359.

Type. École supérieure des Mines, Paris.

Stem 6 cm. long. Pith large, 37–38 mm. in diameter, with three prominent angles, marking the points of origin of lateral

appendages which were borne at equal distances from one another throughout the length of the specimen. Pith solid, parenchymatous, but sometimes the tissues are only imperfectly preserved. The cells are larger in the centre of the pith, and smaller bordering on the wood, where they are 4–5 times higher than broad, and arranged in vertical rows. At the centre, the cells are more irregularly arranged, and are 1–25 times broader than high. Secretory canals, surrounded by a pseudo-sheath of parenchymatous tissue, also occur in this region. They form groups of from 2 to 15 or 20 elements.

Xylem elements exclusively centrifugal, consisting of spiral, annular, and pitted tracheides, as in *Cordaites*, but the pits are usually less numerous and less crowded, and the central pore is exactly circular and not elliptical. The pits are sometimes uniseriate, sometimes biseriate, but not pluriseriate, generally contiguous, rarely distant. The radial rows of tracheides do not form definite bundles, but are grouped together in a variable number of rows, separated by medullary rays. The medullary ray consists of large cells, and is usually only one cell broad, except on the border of the pith. The height of the ray is considerable, and may be as much as fifty superposed cells. The cells are polygonal, elongated in the direction of the ray, generally 5–6 times longer than broad. A few oblique small pits occur in the wall of the cells adjacent to the tracheides. Cortex absent.

Zeiller has figured bacteria found in some of the more altered or decomposed medullary ray cells. He points out that *Dadoxylon Pedroi* resembles *Cordaites* in having a large pith. It differs from that genus in the pith being solid and without diaphragms. In the occurrence of secretory canals in the pith, as well as in the size of the pith, this species recalls the structure of the Cycadeæ. He concludes, however, that this stem has more or less affinity with the Cordaitales, such as perhaps *Noeggerathiopsis* and *Euryphyllum*, but that this suggestion is little more than a conjecture.

Dadoxylon Pedroi is known only from the valley of the Jaguarão, Brazil.

Not represented in the British Museum collection.

3. **Dadoxylon Maitlandi** (Shirley).

1898. *Araucarioxylon Maitlandi*, Shirley, Bull. 7, Geol. Surv. Queensland, p. 14.

Type. Brisbane Museum, Geol. Surv. Coll., Case 53, No. 73.

"Annual zones of wood distinctly marked, and of equal transverse diameter; medullary rays of one or two rows of cells, showing in a tangential section 4–26 cellules, the central few often flanked by a short second row; pits spirally arranged in 2–3 rows. Near the annual zones the tracheides are peculiarly compressed, and the ranks distorted" (from Shirley).

D. Maitlandi is known only from Yam Creek, near Cooktown, Upper Bowen Formation, Queensland.

Not represented in the British Museum collection.

4. **Dadoxylon Binneyi** (Shirley).

1898. *Araucarioxylon Binneyi*, Shirley, Bull. 7, Geol. Surv. Queensland, p. 14, pl. xxv.

Type. Brisbane Museum, Geol. Surv. Coll., No. 77.

"Annual zones of wood distinct, varying much in transverse diameter; medullary rays of a single chain of cellules, in a tangential section numbering 2–9; tracheides usually with three rows of pits, spirally arranged and polygonal by compression" (from Shirley).

D. Binneyi is known only from Jack's Creek, Bowen River, Upper Bowen Formation, Queensland.

Not represented in the British Museum collection.

5. **Dadoxylon Williamsoni** (Shirley).

1898. *Araucarioxylon Williamsoni*, Shirley, Bull. 7, Geol. Surv. Queensland, p. 15.

Type. Brisbane Museum, Geol. Surv. Coll., Case 53, No. 74.

"Annual zones moderately distinct in transverse section, and of equal diameter; medullary rays of one or two rows of cells; tracheides unusually broad, and very unequal; pits spirally arranged in two or three rows, densely packed and polygonal. Near the boundaries of the annual zones the tracheides are peculiarly complicated, and the ranks distorted" (from Shirley).

D. Williamsoni is known only from Jack's Creek, Bowen River, Upper Bowen Formation, Queensland.

Not represented in the British Museum collection.

6. Dadoxylon brisbanense (Shirley).

1898. *Araucarioxylon brisbanense*, Shirley, Bull. 7, Geol. Surv. Queensland, p. 15, pl. xxvi.

Type. Brisbane Museum, Geol. Surv. Coll., No. 91.

"Annual zones of wood well marked, the different zones varying considerably in radial length; tracheides of medium diameter, fusiform or cylindrical, terminations overlapping or ending bluntly; pits small, rounded, usually in two rows spirally arranged; in transverse section the cut ends of the tracheides are sub-quadrate; in tangential section the medullary rays show a single series of 2–10 cells, the average number being five" (from Shirley).

Mr. Shirley has also described some other woods as new species, but in these cases either the precise age is unknown or the preservation does not appear to be very good.

D. brisbanense is known only from Ann Street, North Brisbane.

Not represented in the British Museum collection.

7. Dadoxylon, sp. (from Australia).

The following sections may belong to an undescribed species, but the preservation is not sufficiently good to determine them specifically:—

39,144. *Trans. Sect.* Two sections of a stem, somewhat imperfect in places, showing large rings of growth, the medullary rays, and the tracheides. The petrifaction (three pieces) is also registered under this number.

Port Stephens, New South Wales. *Odinheimer Coll.*

V. 7224. *Trans. Sect.* A section similar to the preceding. The petrifaction (two pieces) is also registered under this number.

Port Stephens, New South Wales. *Odinheimer Coll.*

V. 7226. *Trans. Sect.* A section similar to the last. The petrifaction (two pieces) is registered under this number.

Port Stephens, New South Wales. *Odinheimer Coll.*

V. 7225. *Trans. Sect.* A badly-preserved section, but similar in type to the preceding. The petrifaction (two pieces) is registered under this number.

Port Stephens, New South Wales. *Odinheimer Coll.*

51,458. *Trans. Sect.* A section of an almost complete stem showing the pith-cavity, which is small owing to compression. This stem may be identical with *D. australe*, but without longitudinal sections it is impossible to determine it. The appearance of the transverse section, however, is not quite similar to those described under that species.

Australia. *Nicol Coll.*

51,456. *Trans. Sect.* A similar specimen, cut from the same petrifaction.

Australia. *Nicol Coll.*

V. 8292. *Tang. Long. Sect.* A section showing the tracheides without pits on the tangential walls, and the uniseriate medullary rays.

Queensland.

V. 8293, V. 8294. *Trans. Sects.* Sections showing thick-walled tracheides, with well-marked rings of growth.

Queensland.

V. 8295. *Rad. Long. Sect.* An indifferent section, but showing here and there the multiseriate bordered pits on the walls of the tracheides.

Queensland.

V. 8296. *Tang. Long. Sect.* In this section the walls are falsely pitted owing to imperfect mineral crystallization.

Queensland.

V. 8298. *Rad. Long. Sect.* A poor section.

Queensland.

INCERTÆ SEDIS.

PETRIFIED WOODS (WITHOUT SECTIONS).

39,143. Port Stephens, New South Wales.

32,477. Newcastle, New South Wales. *Pres. by Sir E. Home.*

V. 7289. Port Stephens, New South Wales. *Odinheimer Coll.*

V. 10,650. Over "Dirty Seam," Newcastle, New South Wales. *Keene Coll.*

V. 10,651. Cylindrical piece of wood from a bed of chert.
Wollongong, New South Wales. *Keene Coll.*

V. 10,652. A wedge-shaped piece of wood.
Newcastle Series, New South Wales. *Keene Coll.*

V. 10,654. Stoney Creek, West Maitland, New South Wales. *Keene Coll.*

V. 2394. Six pieces of silicified wood and one obscure specimen.
Beaufort or ? Ecca Series, Kom-kom River (a branch of the Kaga River), south of the Winterburg, Cape Colony.

V. 2395, V. 2395*a*. Two pieces of wood.
Beaufort Series, Zwart-kei River, Cape Colony.

V. 2420. Fossil wood.
Beaufort (?) Series, Rietfontein, near Prince Albert (The Gouph), Cape Colony.

V. 489. ? Ecca Series, New Colesburg Kop (at a depth of 22 feet), De Beers, near Kimberley, South Africa.
Pres. by Prof. T. R. Jones, 1884.

V. 3254. Bedford, Cape Colony.
Pres. by D. Draper, Esq., 1893.

? V. 360. Main street, town of Tette. *Livingstone Coll.*

GYMNOSPERMOUS SEEDS

(Possibly of Cordaitean affinity).

Detached and isolated Gymnospermous seeds occasionally occur in the rocks of Gondwanaland. Some of these probably belong to the Cordaitales or the Coniferales, while others may eventually be referred to the Cycadales or the Ginkgoales.

Genus **CARDIOCARPUS**, Brongniart, 1828.

[Prodr. Hist. Végét. foss., p. 87.]

Platyspermic (bilateral) seeds, lenticular, reniform or cordate. The outer, fleshy portion of the testa (sarcotesta) has often the appearance of being winged. The central body is in most cases the hard sclerotesta, surrounding a cast of the nucellus.

Some seeds of this type are known to belong to members of the Cordaitales. The genus is essentially of Palæozoic age.

1. Cardiocarpus indicus, Zeiller.

(Text-fig. 44.)

1902. *Cardiocarpus indicus*, Zeiller, Pal. Indica, N.S., vol. ii, p. 37, pl. vii, figs. 7, 8.

Type. Nos. 7311–12, Mus. Geol. Surv. India, Calcutta.

Sclerotesta orbicular-cordate, 30–35 mm. in diameter, surrounded by an oval sarcotesta, 50–55 mm. in height and 40–45 mm. broad, at the apex deeply emarginate.

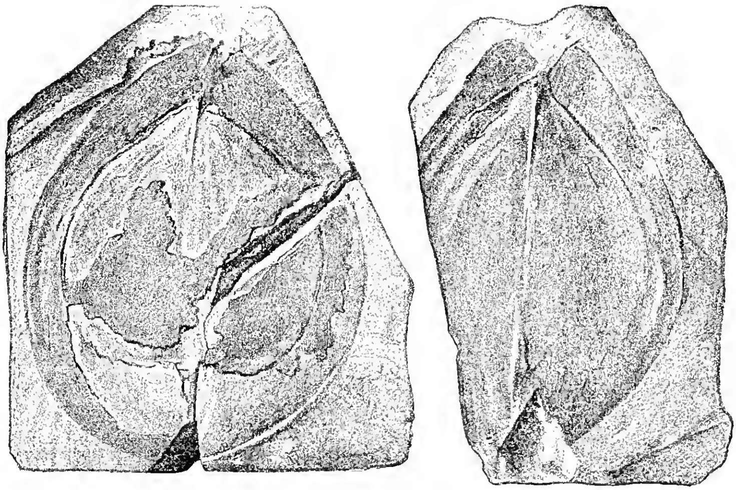

FIG. 44.—*Cardiocarpus indicus*, Zeiller. After Zeiller. Nat. size.

This fine seed (Text-fig. 44), recently described by Zeiller from the Karharbári Group in India, is regarded by him as most probably belonging to a member of the Cordaitales. This species is possibly the largest known member of the genus.

Not represented in the British Museum collection.

2. Cardiocarpus (?) Milleri (Feistmantel).

1879. *Carpolithes Milleri*, Feistmantel, Flora Gondw. Syst., vol. iii, pt. 1, p. 30.

1881. *C. Milleri*, Feistmantel, ibid., vol. iii, pt. 1, Suppl., p. 59, pl. xxx, fig. 14.

1882. *C. Milleri*, Feistmantel, ibid., vol. iv, pt. 1, p. 13, pl. xv, figs. 5–12.

Type. ? Mus. Geol. Surv. India, Calcutta.

Sclerotesta ovate, base rounded, ? emarginate, apex obtuse, 2–3 cm. in height, and 1·4–2 cm. in breadth. Sarcotesta ovate, base emarginate, apex acute, 2·3–3 cm. in height, and 1·8–2·1 cm. in breadth.

In the type-specimen figured by Feistmantel the apex is divided into two lobes, and the sclerotesta has a median groove. The sarcotesta in this species is not much larger than the sclerotesta, and it is possible that this seed may have been of the radiospermic type. For the present, however, it may be referred to the genus *Cardiocarpus*.

Cardiocarpus Milleri occurs only in the Karharbári Beds of India.

Not represented in the British Museum collection.

3. Cardiocarpus, sp. (from India).

Zeiller[1] has figured some seeds from India with a cordate sclerotesta, 7–8 mm. in height and about 7 mm. broad, pointed at the apex, surrounded by a rather narrow sarcotesta, fleshy or perhaps fibrous. This fossil is only known from the Barakar Group, India. It appears to be somewhat similar to the specimen from the Newcastle Series, Australia (see below), which I figured in 1902.[2] Feistmantel[3] has also described several seeds of this type, which he named *Cardiocarpum* (?), sp., *Carpolithes*, sp., and *Samaropsis*, sp.

V. 7110. A nearly perfect specimen of a seed showing the sclerotesta and sarcotesta, the latter having the appearance of being narrowly winged. The sclerotesta measures 6 mm. in length and 6·5 mm. in breadth.

Bharatwada, India. *Hunter Coll.*

V. 7135. A few small seeds, not very well preserved, in association with fronds of *Glossopteris Browniana*. The seeds are possibly referable to *Cardiocarpus*.

Kamthi, India. *Hunter Coll.*

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[1] Zeiller (02[1]), p. 38, pl. vii, fig. 11.

[2] Arber (02[1]), p. 20, text-fig.

[3] Feistmantel (79[1]), p. 30, pl. xxiv, fig. 5; p. 60, pl. xxx, fig. 15; p. 59, pl. xxviii, fig. 8; pl. xxx, figs. 11–13; (80), p. 123, pl. xlvii A, figs. 9–15; (82[1]), p. 50, pl. xi, fig. 7; pl. xvi, fig. 4e; pl. xxi, fig. 2; (86), p. 45, pl. xii A, figs. 7–15; pl. xiv A, figs. 8, 9; pl. v A, figs. 8a–e.

4. **Cardiocarpus**, sp. (from Australasia).

I figured in 1902[1] some subcircular seeds of medium size, from Newcastle in New South Wales, with an oval sclerotesta 5–6 mm. long, and a sarcotesta 6·5–7·5 mm. in height.

Shirley[2] has figured a seed from Queensland as *Cycadospermum Dawsoni*, Shirley, which somewhat recalls some of the Indian seeds noticed above. Johnston[3] has also figured a seed under the name *Carpolithes tasmanicus*, but without description, and others which he compares with *Rhipidopsis*!

32,477. This specimen shows two fragments of large fronds of *Glossopteris Browniana* with broad nets, and a portion of the rhizome, *Vertebraria*. There is also a seed-like body, not very well preserved, of pear-like form, measuring 12 mm. long and 11 mm. across at the widest part. There does not appear to be any wing, and the seed perhaps should be referred to some other genus, but the absence of a wing in this case may be due to imperfect preservation.

Hunter River, New South Wales. *Pres. by Sir E. Home*, 1853.

V. 3776*aa*. A winged seed occurs on this specimen in association with fronds of *Glossopteris* and *Noeggerathiopsis*. The sclerotesta measures 9·5 mm. in length, and the wing is fairly broad.

Mersey River, Tasmania. *Pres. by T. Stephens, Esq.*, 1898.

V. 3776*ah*. Possibly one or two fragments of winged seeds occur on this specimen.

Mersey River, Tasmania. *Pres. by T. Stephens, Esq.*, 1898.

V. 3776*y*. This specimen, in addition to the leaf of *Noeggerathiopsis Hislopi* figured on Pl. VI, Fig. 3, shows a small seed with a fairly broad wing.

Mersey River, Tasmania. *Pres. by T. Stephens, Esq.*, 1898.

V. 3776*ai*. Two or three badly-preserved and rather small seeds occur on this specimen, showing an oval sclerotesta, 5·5 mm. in length, and traces of a narrow wing.

Mersey River, Tasmania. *Pres. by T. Stephens, Esq.*, 1898.

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[1] Arber (02[1]), p. 20, text-fig.
[2] Shirley (02), p. 9, pl. iii.
[3] Johnston (88), pp. 111, 134, pl. viii, fig. 7: p. 134, pl. viii, figs. 1–6.

5. **Cardiocarpus,** sp. (from South Africa).

V. 3614. Figured by Seward (97[1]), p. 332, text-fig. 1*d* on p. 324. A small seed, 9 mm. long and 6·5 mm. in breadth. Mr. Seward has pointed out that the broad margin surrounding the oval central region is interrupted at the base by what appears to be a canal leading to the base of the seed. This seed occurs with another specimen, described by Mr. Seward as a leaf of doubtful affinity.

Casey's Township, Transvaal. *Pres. by D. Draper, Esq.*, 1897.

Class CYCADOPHYTA.

The term Cycadophyta has been recently proposed by Nathorst to include fossil fronds similar in habit to those of the recent Cycads, whose affinities, whether to that family or to other extinct races of the same stock, are at present unknown. Such fossils appear first in the Permo-Carboniferous rocks, and are especially characteristic of the Mesozoic period. A few Cycads, remnants of what was once a great and complex group, still survive at the present day.

Genus **PTEROPHYLLUM,** Brongniart, 1825.

[Ann. Sci. Nat., ser. I, vol. iv, p. 211.]

Fronds simply pinnate, pinnæ attached to the rachis by their whole base, usually linear, with parallel sides, generally considerably longer than broad, truncated, rounded, or, more rarely, pointed at the apex, more or less spreading, sometimes curved. Nerves parallel, simple or dichotomously divided.

This genus is one of the earliest of Cycadean fronds, appearing first in the Carboniferous, and reaching its maximum in the Triasso-Rhætic. In the Jurassic and Cretaceous rocks it is less abundant.

Pterophyllum (Anomozamites) Balli (Feistmantel).

(Text-fig. 45.)

1881. *Anomozamites (Pterophyllum) Balli*, Feistmantel, Rec. Geol. Surv. India, vol. xiv, pt. 3, p. 256, pl. ii, figs. 3, 4.

1886. *Platypterygium Balli*, Feistmantel, Flora Gondw. Syst., vol. iv, pt. 2, p. 37, pl. ii A, figs. 4–8; pl. iii A, fig. 2 (pars).
1902. *Pterophyllum (Anomozamites) Balli*, Zeiller, Flore Foss. Gîtes Charb. Tonkin, p. 182.

Type. Nos. 5504–8, Mus. Geol. Surv. India, Calcutta.

Frond of medium size, elliptical, pinnately divided. Segments linear, of unequal breadth, decurrent at the base and truncated at the apex, apparently attached laterally to the rachis. Nerves 4–8, sub-parallel, simple or more often dichotomising, the first dichotomy taking place near the base of the segments.

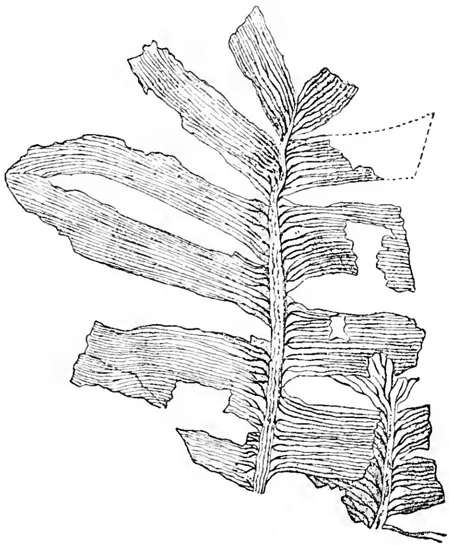

FIG. 45.—*Pterophyllum (Anomozamites) Balli* (Feist.). After Feistmantel. Nat. size.

The name *Anomozamites* was originally instituted by Schimper to include a particular type of frond belonging to the large genus *Pterophyllum*, in which the leaflets are rectangular, truncated at the apex, with rounded angles, the distal margin being parallel to the rachis.

Zeiller[1] has recently described some fronds of this type from the

[1] Zeiller (02[3]), p. 177, pl. xliii, fig. 8; pl. xliv, figs. 1–5.

Rhætic of Tonquin, one of which, *Pterophyllum* (*Anomozamites*) *inconstans* (F. Braun), is not unlike Feistmantel's species. There can be little doubt that these fronds are of the Cycadean type, according to the at present accepted views as to the nature of such leaves.

Pterophyllum (*Anomozamites*) *Balli* is known only from the Barákar Group of the Damuda division in India.

Not represented in the British Museum collection.

Genus **CYCADITES**, Sternberg, 1826.

[Flora Vorwelt, Heft iv, p. xxxii.]

Frond pinnate, pinnæ alternate or opposite, linear, lanceolate, entire, with a single median vein; attached to the rachis by the entire base, the lower margin of which may be slightly decurrent on the frond axis, or slightly narrowed towards the point of attachment.[1]

Cycadites (?), sp.

1902. *Cycadites* (?), sp., Zeiller, Pal. Indica, N.S., vol. ii, p. 33, pl. vii, figs. 4, 5.

Zeiller has recently ascribed to this genus, provisionally, a single, linear, uninerved leaf, 6 cm. long and 5 mm. broad, from the Karharbári Group of India, which is the only specimen of its kind known from Gondwanaland.

Not represented in the British Museum collection.

Class ? GINKGOALES.

The class Ginkgoales includes fossil remains, chiefly foliage leaves and flowers, which may be compared more or less closely with *Ginkgo* (*Salisburia*), the Maidenhair-tree of Japan and China, now the sole survivor of what was once a great group of Gymnosperms. Such remains appear first in Permo-Carboniferous times, and are especially characteristic of the Mesozoic period.

[1] Seward (95), p. 24.

Genus RHIPIDOPSIS, Schmalhausen, 1879.

[Mém. Acad. Imp. Sci. St. Pétersb., ser. VII, vol. xxvii, p. 50.]

Leaves large, usually orbicular or oval, with a long petiole, palmisect, coriaceous. Segments 5–10, cuneate, entire, obtuse, flabellate, lateral segments usually smaller than the median. Nerves numerous, radiating, several times dichotomised.

This genus was instituted by Schmalhausen for the reception of some large leaves from rocks of Permian age in Russia not dissimilar in habit to those of *Ginkgo*. Similar leaves have since been found in the Permo-Carboniferous of India and Argentina.

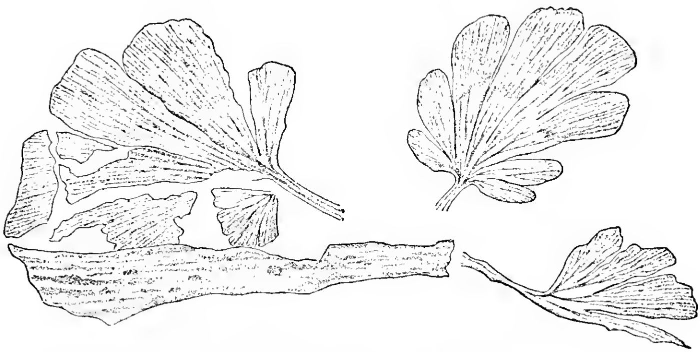

Fig. 46.—*Rhipidopsis gingkoides*, Schmal. After Feistmantel. Nat. size.

1. Rhipidopsis ginkgoides, Schmalhausen.

(Text-fig. 46.)

1879. *Rhipidopsis gingkoides*, Schmalhausen, Mém. Acad. Imp. Sci. St. Pétersb., ser. VII, vol. xxvii, p. 50, pl. viii, figs. 3–12; pl. vi, fig. 1.

1881. *R. gingkoides*, Feistmantel, Rec. Geol. Surv. India, vol. xiv, pt. 3, p. 257, pl. ii, fig. 2.

R. gingkoides, Feistmantel, Flora Gondw. Syst., vol. iii, pt. 3, p. 122.

1885. *R. ginkgoides*, Renault, Cours Bot. foss., 4e ann., p. 67, pl. v, figs. 3, 4, 7, 8.

1886. *R. gingkoides*, Feistmantel, Flora Gondw. Syst., vol. iv, pt. 2, p. 43, pl. iii A, figs. 1, 2.

1895. *R. ginkgoides*, Bodenbender, Rev. Mus. La Plata, vol. vii, table opposite p. 148.

1896. *R. ginkgoides*, Bodenbender, Zeitschr. deutsch. geol. Gesell., vol. xlviii, table opposite p. 772.

1900. *R. ginkgoides*, Zeiller, Élém. Paléobot., p. 250, text-fig. 177.

Type. ? St. Petersburg.

Leaves palmisect, large, with segments measuring 2–11 cm. in length. Segments 6–10, entire, lateral segments obovate, median segments cuneiform, truncated distally. Nerves fairly numerous, very distinct, dividing by dichotomy several times.

The Indian fronds which Feistmantel has identified with *Rhipidopsis ginkgoides* are distinctly smaller than those figured by Schmalhausen, but, so far as one can judge without seeing the actual specimens, they appear to be identical.

R. ginkgoides occurs in Gondwanaland in the Barákar Group of India, and has been recorded from the Permo-Carboniferous of South America.

Not represented in the British Museum collection in association with the Glossopteris flora.

2. Rhipidopsis densinervis, Feistmantel.

1881. *Rhipidopsis densinervis*, Feistmantel, Flora Gondw. Syst., vol. iii, pt. 3, p. 121, pl. xlviA, figs. 1, 2, 2*a*.

1896. *R. densinervis*, Bodenbender, Zeitschr. deutsch. geol. Gesell., vol. xlviii, table opposite p. 772.

Type. Nos. 5337–8, Mus. Geol. Surv. India, Calcutta.

Leaves stalked, coriaceous. Segments usually 6, broadly cuneate, apex lobed or ? incised. Nerves very numerous, close, repeatedly dichotomous.

As Feistmantel has pointed out, this species differs from that first described by Schmalhausen (*Rhipidopsis ginkgoides*) by the closer nervation, and in the segments being incised.

R. densinervis occurs in the Raniganj Group in India, and in the Permo-Carboniferous rocks of Argentina.

Not represented in the British Museum collection.

Genus PSYGMOPHYLLUM, Schimper, 1870.

[Traité, vol. ii, p. 192.]

Folia pinnatisecta, pinnis erecto-patentibus, e basi valde angustata flabelliformibus (unde nomen), longitudinaliter flabellatim plicatis, plus minus profunde pinnatisectis, vel margine lobatis seu crenatis; nervis pluries dichotomis, erecto-radiantibus. Vernatio foliorum verticaliter involuta.

Psygmophyllum is a type of leaf which has given rise to some

difference of opinion as to its precise affinities. Schimper included it with the Cycads, while in more recent years Zeiller,[1] Seward, and others have provisionally referred it to the Ginkgoales. Mr. Seward[2] has remarked that we have little evidence on this point beyond a not very close resemblance between these leaves and those of the genus *Ginkgo*. The same author has compared Feistmantel's *Euryphyllum Whittianum*, here referred to the genus *Noeggerathiopsis*, with the members of this genus.

Distribution.—*Carboniferous* of England, Spitzbergen, Germany. *Permian* of Russia, France. *Permo-Carboniferous* (Glossopteris flora), Cape Colony and ? Kashmir.

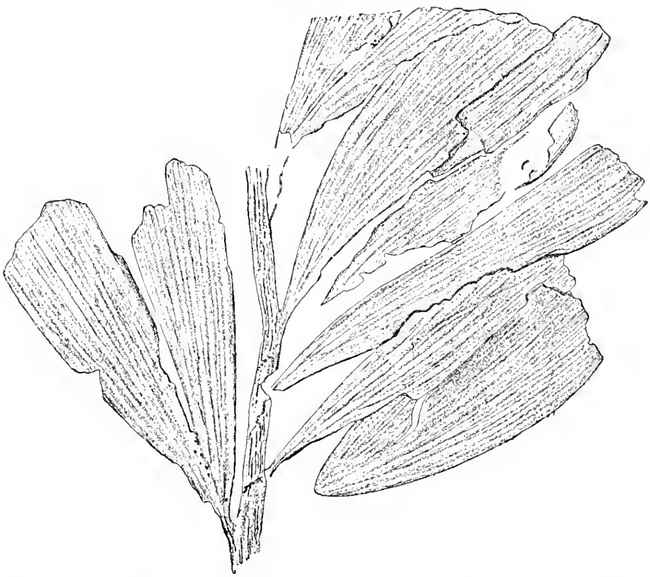

FIG. 47.—*Psygmophyllum Kidstoni*, Seward. After Seward. ½ nat. size.

1. Psygmophyllum Kidstoni, Seward.

(Text-fig. 47.)

1903. *Psygmophyllum Kidstoni*, Seward, Ann. S. African Mus., vol. iv, pt. 1, p. 93, pl. xii, fig. 1.

Type. South African Mus., Cape Town.

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[1] Zeiller (00[1]), p. 251.

[2] Seward (03[1]), p. 92.

Vegetative shoots woody, bearing spirally disposed leaves. Leaves wedge-shaped, reaching a length of 13 cm., usually divided by a deep median sinus into two narrow wedge-shaped lobes, truncate distally and tapering gradually to the proximal end of the lamina. Leaves sessile, attached to the axis by a narrow base. The lamina is traversed by numerous spreading and occasionally forked veins, following a course parallel with the edge of the leaf. Organs of reproduction unknown.[1]

Mr. Seward has pointed out that the South African leaves bear a close resemblance to those of the British Lower Coal Measure species *Psygmophyllum flabellatum* (L. & H.), and also to the individual leaflets of the compound leaf, *Rhipidopsis ginkgoides*, from India.

Psygmophyllum Kidstoni is known only from the Permo-Carboniferous rocks of the Transvaal.

Not represented in the British Museum collection.

2. **Psygmophyllum (?)**, sp. (from Kashmir).

Mr. Seward[2] has recently figured an imperfect impression from Kashmir, which he doubtfully assigns to this genus. It differs from the other members recorded in the lamina of the leaf being shorter and relatively broader. The leaf is divided into two symmetrical halves by a shallow groove, which may be due to lobing, or possibly to some extent to tearing. The petiole is absent. The veins are numerous, radially disposed, simple, or occasionally dichotomised. Mr. Seward also compares this specimen with *Ginkgo*, *Actinopteris*, and *Rhipidopsis*.

Genus **OTTOKARIA**, Zeiller, 1902.

[Pal. Indica, N.S., vol. ii, prelim. note.]

The characters of this genus are those of the only known species, *Ottokaria bengalensis*. Zeiller[3] described this leaf under the name *Feistmantelia*, but he transferred it subsequently[3] to a new genus *Ottokaria*, as the former designation had been already used by Mr. Lester Ward for another fossil.

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[1] Seward (03²), p. 93.
[2] Seward (05), pp. 6, 7, pl. ix, fig. 3.
[3] Zeiller (02¹), p. 34, and prelim. note.

Ottokaria bengalensis, Zeiller.

1902. *Feistmantelia bengalensis*, Zeiller, Pal. Indica, N.S., vol. ii, p. 34, pl. iv, figs. 9, 10.
Ottokaria bengalensis, Zeiller, ibid., prefatory note.

Type. Nos. 7287–8, Mus. Geol. Surv. India, Calcutta.

Leaf orbicular, with a long petiole, measuring 30 mm. in diameter, margin sub-acutely dentate, nerves consisting of fine strands united into bundles, radiating from the base of the leaf and dividing dichotomously.

Zeiller[1] has pointed out that the details of the nervation of the Indian leaf may be closely compared with those of the genus *Whittleseya*, especially *W. elegans*, Newberry, from the Carboniferous of the United States, although the form of the leaf is altogether different. In the latter respect he has compared this new species with certain Mesozoic members of the genera *Baiera* and *Ginkgo*, and with *Rhipidopsis ginkgoides*, Schmal. He concludes that the Indian fossil may be referred provisionally to the Ginkgoales.

Ottokaria bengalensis is known only from a single specimen, derived from the Karharbári Beds at Passerabhia, India.

Not represented in the British Museum collection.

Class CONIFERALES.

Seed-bearing plants, usually trees, more rarely shrubs, with much-branched stems. Leaves numerous, simple, entire, comparatively small. Flowers unisexual, without perianth, ovules naked.

Genus VOLTZIA, Brongniart, 1828.

[Prodr. Hist. Végét. foss., p. 108.]

Branches pinnately arranged. Leaves dimorphic; the smaller tetragonal, decurrent at the base, falciform, keeled, acuminate. The larger leaves, especially towards the ends of the branches, long, linear, more or less distichous. Cones cylindrical, very elongate, composed of scales loosely imbricate, coriaceous, lobed distally into 3–5 rounded lobes, each usually subtending 2–3 winged seeds.

[1] Zeiller (02), p. 35.

Voltzia appears first in the Upper Carboniferous of the Northern Hemisphere, and extends to the Permian, Triassic, and Rhætic. It is also found in the Permo-Carboniferous rocks of Gondwanaland. It is one of the earliest known members of the group, and is unlike any recent family of Conifers, although it stands nearest to the Araucarieæ.

Voltzia heterophylla, Brongniart.

(Text-fig. 48.)

1828. *Voltzia heterophylla*, Brongniart, Prodr. Hist. Végét. foss., p. 108.
V. brevifolia, Brongniart, ibid., p. 108.
V. rigida, Brongniart, ibid., p. 108.
V. heterophylla, Brongniart, Ann. Sci. Nat., vol. xv, p. 451.
V. brevifolia, Brongniart, ibid., p. 499, pl. xv; pl. xvi, figs. 1–4; pl. xvii, fig. 1.
V. rigida, Brongniart, ibid., p. 450, pl. xvii, fig. 2.
V. elegans, Brongniart, ibid., p. 450, pl. xvii, fig. 3.
1844. *V. heterophylla*, Schimper & Mougeot, Monogr. Plant. foss. Grès bigarré, p. 25, pls. vi–xiv.
1850. *V. heterophylla*, Göppert, Monogr. Foss. Conif., p. 194, pl. xxiii, figs. 1–6.
1864. *V. heterophylla*, Göppert, Palæontogr., vol. xii, p. 232, pl. xlvii, fig. 1.
V. heterophylla, Weiss, Neu. Jahrb. Miner., p. 287, pl. v, figs. 1–10.
1865. *V. heterophylla*, Heer, Urwelt Schweiz, p. 52, text-fig. 30.
1870–2. *V. heterophylla*, Schimper, Traité, vol. ii, p. 241, pl. lxxiv, figs. 1–7.
1879. *V. heterophylla*, Feistmantel, Flora Gondw. Syst., vol. iii, pt. 1, p. 28, pl. xxii; pl. xxiii; pl. xxiv, ? fig. 4; pl. xxv.
1881. *V. heterophylla*, Feistmantel, ibid., vol. iii, pts. 2, 3, p. 122, pl. xlvii A, figs. 20, 22, 24, ? 19.
1882. *V. heterophylla*, Feistmantel, ibid., vol. iv, pt. 1, p. 43.
1885. *V. heterophylla*, Renault, Cours Bot. foss., 4e ann., p. 111, pl. xiii, figs. 1–6.
1886. *V. heterophylla*, Feistmantel, Flora Gondw. Syst., vol. iv, pt. 2, p. 45.
V. heterophylla, Blanckenhorn, Palæontogr., vol. xxxii, pt. 4, pp. 135, 141, pl. xxii, figs. 17–20.
1893. *V. heterophylla*, Oldham, Man. Geol. India, pl. opp. p. 158.
1900. *V. heterophylla*, Zeiller, Élém. Paléobot., p. 267, text-fig. 192.
1901. *V. heterophylla*, Schütze, Jahresb. Ver. Naturk. Würtemburg, vol. lvii, p. 244.
1903. *V. heterophylla*, Leuthardt, Abhand. Schweiz. paläont. Gesell., vol. xxx, p. 10, pl. iv, figs. 2–5.

Type. ? Muséum d'histoire naturelle, Paris.

Leaves dimorphic. Lower leaves little developed, short, subfalcate, linear; upper leaves elongate, linear, narrow, somewhat spreading. Strobilus oblong, cylindrical, composed of laxly imbricated scales, with a 5-lobed apical expansion.

FIG. 48.—*Voltzia heterophylla*, Brong. After Feistmantel. Nat. size.

This species, which occurs chiefly in the Trias of Europe (especially the Bunter of the Vosges), has, I think, been correctly determined by Feistmantel from the Karharbári and Raniganj

Groups of India. Similar but fragmentary specimens from East Africa have been referred by Potonié[1] to the genus *Voltziopsis.*

Not represented in the British Museum collection from the Palæozoic rocks.

Seeds possibly belonging to Voltzia.

Feistmantel[2] has noticed the occurrence of numerous small ovoidal seeds, slightly winged, in the *Glossopteris*-bearing beds in India, in association with *Voltzia.* Zeiller[3] has figured some small ovoid, pointed seeds from India, 3–4 mm. long, and 2–2·5 mm. broad, with a very narrow wing, which he is also inclined to attribute to the same genus. A number of minute seeds from the Transvaal were also figured by the same author[4] in 1896, but in this case he did not offer any suggestion as to the plant to which they belong. While no doubt they are not of the same nature as those above mentioned, they may, however, be compared with them.

Genus **ALBERTIA**, Schimper & Mougeot, 1844.

[Monogr. Plant. foss. Grès bigarré, p. 14.]

Coniferous trees, with numerous leaves, slightly stalked at the base. Leaves oval, elongate, obtuse, spreading.

Albertia occurs in the Bunter of the Northern Hemisphere, and possibly also in the Permo-Carboniferous of India.

The genus is not well known at present, and its affinities are doubtful. Some of the leaves which have been referred to it recall those of certain of the recent Araucarieæ, especially *Agathis Dammara.*

Albertia (?), sp., from India.

Feistmantel[5] has described some axes bearing elongate, cuneiform leaves, some of which appear to be deeply toothed at the apex.

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[1] Potonié (00), p. 504, text-fig. 29.

[2] Feistmantel (82^1), p. 50.

[3] Zeiller (02^1), p. 39, pl. vii, figs. 9, 10.

[4] Zeiller (96^1), p. 374, pl. xvi, fig. 13; pl. xviii, fig. 10.

[5] Feistmantel (79^1), p. 29, pl. xxiv, fig. 3; pl. xxvi, fig. 2; ? pl. xxiv, figs. 1, 2; (80), p. 123.

He has compared them with *Albertia speciosa* of Schimper & Mougeot, but their characters do not agree in several respects with those of that species, and their generic determination is at present not free from doubt.

These leaves are known only from the Karharbári Group of India.
Not represented in the British Museum collection.

Genus CYCLOPITYS, Schmalhausen, 1879.

[Mém. Acad. Imp. Sci. St. Pétersb., ser. VII, vol. xxvii, p. 39.]

Leaves whorled, linear, acute, traversed by a median nerve, slightly wrinkled transversely.

This genus was instituted by Schmalhausen for some leaves of

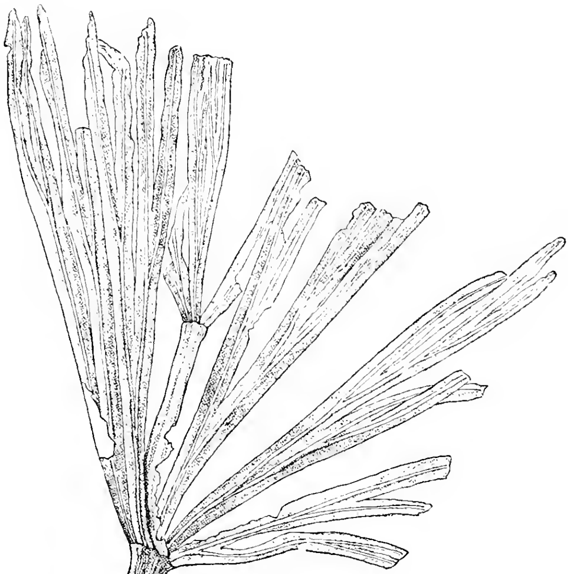

FIG. 49.—*Cyclopitys dichotoma*, Feist. After Feistmantel. $\frac{2}{3}$ nat. size.

the Coniferous type occurring in Permian rocks, which he compared with those of the recent conifer *Sciadopitys*, and included in the recent family Taxoidieæ. Similar leaves were later described from

the Permo-Carboniferous beds of India by Feistmantel. The latter specimens are, however, fragmentary, and while considerable doubt must remain as to their true affinities, Feistmantel's generic determination may perhaps be retained for the present. The genus has also been recorded from Argentina.

Cyclopitys dichotoma, Feistmantel.

(Text-fig. 49.)

1881. *Cyclopitys dichotoma*, Feistmantel, Rec. Geol. Surv. India, vol. xiv, pt. 3, p. 257, pl. ii, fig. 6.
Cyclopitys, sp., Feistmantel, Flora Gondw. Syst., vol. iii. pts. 2, 3, p. 122.
1886. *C. dichotoma*, Feistmantel, ibid., vol. iv, pt. 2, p. 44, pl. iii A, figs. 3, 4; pl. iv A, fig. 6.
1896. *C. dichotoma*, Bodenbender, Zeitschr. deutsch. geol. Gesell., vol. xlviii, table opposite p. 772.

Type. Nos. 5511–12, 5518, Mus. Geol. Surv. India, Calcutta.

Stem striated; five or more leaves in a whorl. Leaves coriaceous, forked two or three times. Median nerve strong, dividing dichotomously twice or thrice to supply the segments of the leaf.

Feistmantel described this species from the Barákar Group of India. The leaves appear to be longer and stronger than in Schmalhausen's plant. The Indian species has also been recorded from Argentina.

Not represented in the British Museum collection.

Genus **BRACHYPHYLLUM**, Brongniart, 1849.

[Tableau Végét. foss., p. 69.]

"Branchlets generally thick, clothed with very short, spirally arranged, scale-like leaves, apparently somewhat fleshy, with a broad, rhomboidal base, usually furnished with a dorsal keel, prolonged into a blunt or sharp point."

As Mr. Seward[1] has remarked, this genus is very unsatisfactory and difficult to define accurately. It is almost entirely a Mesozoic type, occurring in the Rhætic, Jurassic, and Wealden rocks. Feistmantel has doubtfully compared some twigs of Coniferous affinities belonging to the Glossopteris flora with the Mesozoic members of this genus.

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[1] Seward (95), p. 214.

Brachyphyllum (?) australe, Feistmantel.

(Text-fig. 50.)

1878. *Brachyphyllum* (?) *australe*, Feistmantel, Palæontogr., Suppl. iii, pp. 97, 98, pl. vii, figs. 3–6; pl. xvii.
1883. *B.* (?) *australe*, Tenison-Woods, Proc. Linn. Soc. New South Wales, vol. viii, p. 159.
1890. *B.* (?) *australe*, Feistmantel, Mem. Geol. Surv. New South Wales, Pal., No. 3, p. 162, pl. xv, fig. 4; pl. xxii, figs. 1, 2.

Type. ? Australian Museum, Sydney.

"Branchlets elongate, slender, flexuous, leaves spirally disposed, squamiform, rhomboid-oblong, somewhat thick, apex acuminate,

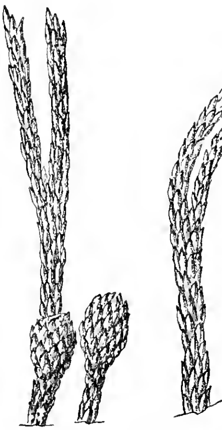

Fig. 50.—*Brachyphyllum* (?) *australe*, Feist. After Feistmantel. Nat. size.

sub-keeled and a little flattened, amentum covered with sub-rhomboid, acute, acuminate scales, the apex somewhat flattened and spirally disposed."

Feistmantel's description, quoted above, and his figures certainly seem to agree fairly well with the characters of some of the known members of this genus. He compares the Australian species with *Echinostrobus Sternbergi*, Schimp., *Palissya aptera*, Schenk, and *Brachyphyllum Papareli*, Sap.

Brachyphyllum (?) *australe* is known only from the Newcastle Beds of New South Wales.

Not represented in the British Museum collection.

Genus **ARAUCARITES**, Presl, 1838.

[In Sternberg, Flora Vorwelt, Heft vii, p. 203.]

Leaves and cones essentially similar to those of the recent genus *Araucaria*. With the exception of the following species, the genus has so far been found only in the Mesozoic rocks.

Araucarites Oldhami, Zeiller.

1902. *Araucarites Oldhami*, Zeiller, Pal. Indica, N.S., vol. ii, p. 36, pl. vii, fig. 6.

Type. No. 7310, Mus. Geol. Surv. India, Calcutta.

Branches strong, 10–12 mm. broad; leaves erectly spreading, lanceolate, 35–40 mm. long, 9–12 mm. broad, apex acute, attached by a rhomboidal cushion or pulvinus 5–6 mm. in height; nerves fine, crowded, parallel.

The specimen, recently described by Zeiller, agrees closely in its characters with certain recent Araucarieæ, but in the absence of the fructification it is not safe to refer it to the recent genus. The leaves of this species are probably longer than those of any other known member of the genus. The horizon in the Lower Gondwanas of India from which the specimen was obtained at the Moran River is not certain.

Not represented in the British Museum collection.

Genus **WALCHIA**, Sternberg, 1826.

[Flora Vorwelt, Heft iv, p. xxii.]

Branches regularly pinnate, spreading in one plane, numerous, approximate. Leaves small, falciform, keeled, decurrent at the base, erect or spreading.

In habit *Walchia* recalls certain Araucarieæ, especially *Araucaria excelsa*. It is essentially a Palæozoic genus, appearing first in the Carboniferous and reaching its maximum in the Permian period.

[Walchia], sp. (from South America).

Kurtz[1] has described a very imperfect fragment, apparently of a Coniferous branch, from Argentina, which he has doubtfully

[1] Kurtz (94[1]), p. 133, pl. iv, fig. 7.

referred to this genus. Judging by his figure, the specimen appears to me to be hardly capable of generic identification.

Scale-leaves of Gymnospermous affinity.

Feistmantel[1] has figured a number of obovate or obovately triangular leaves, with a truncated base, and a radiating nervation. These he regarded as scale-leaves of Gymnospermous affinity. The specimens were obtained from the Karharbári, Barákar, and Raniganj Groups in India. Somewhat similar scale-leaves from Australia were also noticed by Dana.[2]

PLANTÆ INCERTÆ SEDIS.

Genus **CONITES**, Sternberg, 1824.

[Flora Vorwelt, Heft iii, p. 36.]

This generic name has been revived recently by Mr. Seward[3] for isolated cones of doubtful affinity.

Conites, sp. (from South Africa).

V. 3615. Figured by Seward (97[1]), p. 331, pl. xxii, fig. 2.

A small cone, 2 cm. long and 1 cm. broad, associated with a leaf of *Gangamopteris.* Mr. Seward describes the surface as showing "4 to 6-sided areas, measuring 2 mm. in length, and from 1 to 1·5 mm. in breadth, which appear to be the proximal ends of thick scales which expanded distally. The proximal ends appear to be solid; the fractured appearance of a few of the areas is probably accidental, and does not indicate originally hollow scales. Had the scales been hollow, the specimen would have presented a close agreement with an Araucarian cone, and it is still possible that it may represent a number of Araucarian scales detached from a broad central axis, and seen from the inside."

Vereeniging, Transvaal. *Pres. by D. Draper, Esq.*, 1898.

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[1] Feistmantel (80), p. 119, pl. xlviiA, figs. 8, 16–18, 21, 23; (82[1]), p. 42, pl. xiv, figs. 4, 5, 7, 8, 10.

[2] Dana (49), p. 714, pl. xii, figs. 1–8.

[3] Seward (95), pp. 113, 222.

Genus **DICTYOPTERIDIUM**, Feistmantel, 1881.

[Flora Gondw. Syst., vol. iii, pts. 2, 3, pp. 7, 14, 34, 47.]

Dictyopteridium is a genus instituted, but not defined, by Feistmantel for the reception of some small specimens which he regarded as fertile fern fronds, but which, as Zeiller has pointed out, are more probably roots or rhizomes.

Dictyopteridium sporiferum, Feistmantel.

(Text-fig. 51.)

1881. *Dictyopteridium sporiferum*, Feistmantel, Flora Gondw. Syst., vol. iii, pts. 2, 3, pp. 7, 14, 34, 47, pl. xxiiiA, figs. 4–6, 14, 14*a*.

1886. *Dictyopteridium*, sp., Feistmantel, ibid., vol. iv, pt. 2, p. 34, pl. VA, fig. 3.

1902. *D. sporiferum*, Zeiller, Pal. Indica, N.S., vol. ii, p. 24, pl. iv, fig. 8.

Type. Nos. 5210–12, Mus. Geol. Surv. India, Calcutta.

This species, like the genus, was not described fully by Feistmantel in the systematic portion of his work. The specimens he figures appear to be small, linear or lanceolate bodies, covered with small tubercles, the marginal tubercles being larger than the others. He regarded them as the fertile leaflets of some fern.

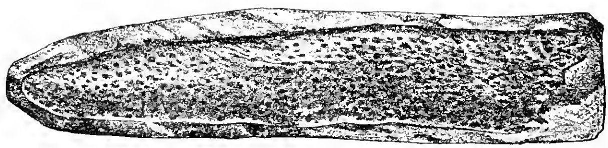

Fig. 51.—*Dictyopteridium sporiferum*, Feist. After Zeiller. Nat. size.

Zeiller has recently figured a further specimen (Text-fig. 51), and though the nature of these bodies is not yet clear, he thinks they are more probably roots, or fleshy rhizomes bearing roots. A thorough examination has shown no trace of a sporangium, but very small circular scars with a central print have been found. Feistmantel says a very fine net nervation can be seen on magnification, but Zeiller has failed to find any evidence of this nature.

It may be pointed out that some of the specimens included by Feistmantel[1] under this name are merely scale-fronds of *Glossopteris*.

Dictyopteridium sporiferum is known only from the Talchir and Raniganj groups in India.

Not represented in the British Museum collection.

[1] Feistmantel (80), pp. 13, 46, pl. xliiA, fig. 4; (82), p. 39.

APPENDIX.[1]

Genus **SPHENOPHYLLUM**, Brongniart, 1822 (*ante*, p. 34).

1. **Sphenophyllum speciosum** (Royle) (*ante*, p. 35).

V. 10,894. A whorl of wedge-shaped leaves, of which six are seen, some of them being almost perfect. The nervation is fairly well preserved.

Nágpur, India. *Sankey Coll.*

Genus **GANGAMOPTERIS**, McCoy, 1861 (*ante*, p. 102).

6. **Gangamopteris kashmirensis**, Seward.

1905. *Gangamopteris kashmirensis*, Seward, Pal. Indica, N.S., vol. ii, Mem. 2, p. 3, pl. viii, figs. 1–6; pl. ix, figs. 1, 2.

Type. Mus. Geol. Surv. India, Calcutta.

Frond simple, varied in size, reaching a length of considerably over 20 cm., long and narrow with a fairly uniform breadth of approximately 2 cm., or tongue-shaped and exceeding 4 cm. in breadth. Apex broadly lanceolate, lamina gradually narrowed towards the base, becoming petiolate, and terminating in a slightly broader base. No prominent midrib. The median region is occupied by several slender veins which occasionally join one another laterally by oblique cross-connections; from the median veins lateral branches are given off which bend outwards and upwards as crowded lateral veins, which, in the broader form of leaf, cut the margin almost at right-angles. The strongly curved arches formed by the secondary veins frequently anastomose by oblique veinlets which produce comparatively long and narrow meshes. In the apical portion, the nerves are numerous, spreading,

[1] While this work was passing through the press, a few further specimens have been presented, or recognised, and are described here.

and highly inclined. The petiolar portion of the leaf is traversed by longitudinal anastomosing veins without lateral veins. The base is characterised by the presence of a few comparatively broad ridges or grooves which are apparently formed by the union of several smaller veins. Fructification unknown.

This plant has been recently discovered by Dr. Noetling at Khunmu, in the Vihi Valley, 15 miles south-east of Srinagar in Kashmir, in beds apparently below Permian marine sediments. It has been figured by Mr. Seward, from whose description this account is taken. That author distinguishes it from *Gangamopteris cyclopteroides* by the flatter form of the arch formed by the lateral veins, and by the greater inclination of the veins to the margin of the lamina. Several specimens were obtained in association with another fossil (see p. 214) doubtfully referred by Mr. Seward to the genus *Psygmophyllum.*

V. 10,895. A small piece of a frond of linear form, closely similar to that figured by Seward on pl. viii, fig. 4. It measures 7 cm. long and 2·7 cm. across. In the median portion the nervation is not preserved, but the lateral veins are fairly clear.

Khunmu, Vihi Valley, Kashmir.

Pres. by the Director, Geol. Surv. India, 1905.

V. 10,896. A broad frond, 15 cm. long and 6·2 cm. broad. It resembles that figured by Seward on pl. viii, fig. 2. The nerves are very indistinct, but here and there a trace of the median and lateral nervation is visible.

Khunmu, Vihi Valley, Kashmir.

Pres. by the Director, Geol. Surv. India, 1905.

V. 10,897. A narrow frond, 11 cm. long, rather badly preserved, showing only the median nerves.

Khunmu, Vihi Valley, Kashmir.

Pres. by the Director, Geol. Surv. India, 1905.

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(30), pp. 209–248, pls. l, liii, lvii–lviii, lxi *bis*, lxii, lxiv–lxv, lxvii–lxviii, lxx–lxxi, lxxiii, lxxvi.

(31–2), pp. 249–264, pls. lix–lx, lxiii, lxix, lxxii, lxxiv–lxxv, lxxvii–lxxxii.
(32–3), pp. 265–288, pls. lxxxiii–xcvii.
(33–4), pp. 289–312, pls. lxxxii A, xcviii–cix.
(34), pp. 313–336, pls. cx–cxiv, cxvii–cxviii, cxxiv, cxxvii–cxxviii, cxxx.
(35–6), pp. 337–368, pls. cxv–cxvi, cxix–cxxiii, cxxv–cxxvi, cxxix, cxxxi–cxxxiv.
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INDEX.

[Synonyms are printed in *italics*, and casual references to genera and species in *italic numbers*.]

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EXPLANATION OF PLATES.

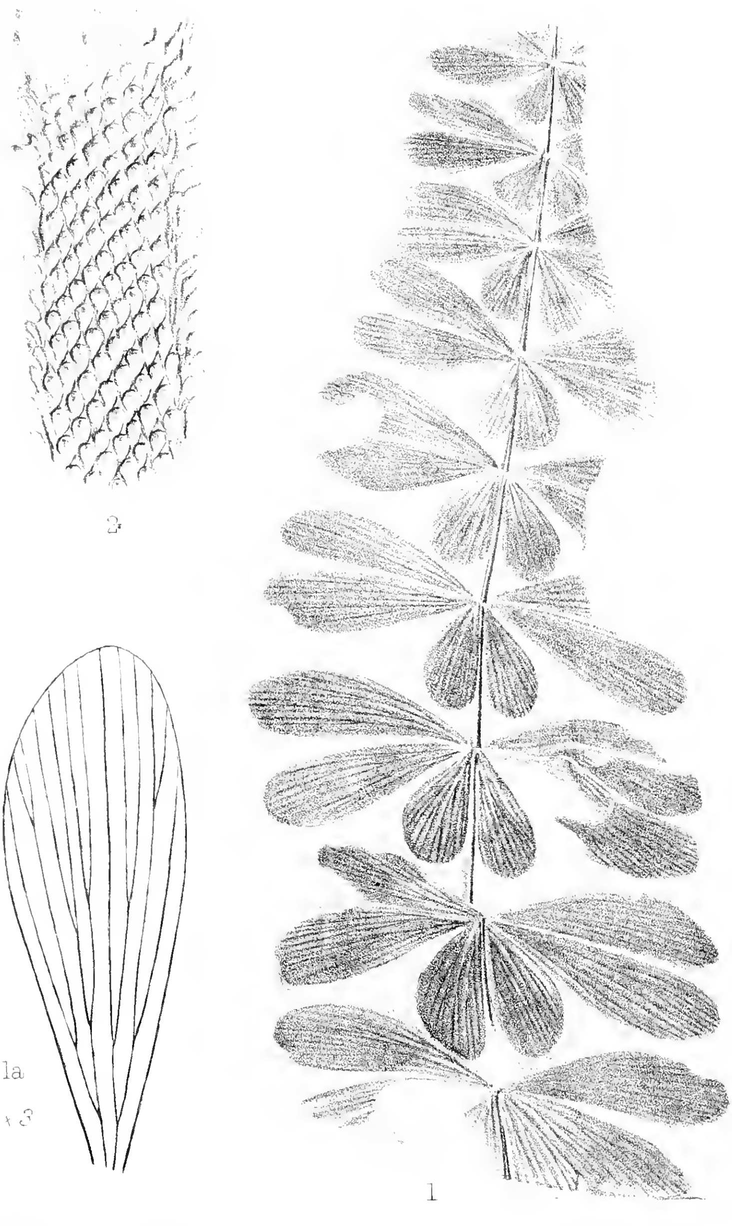
ALL the figured specimens are preserved in the Geological Department, British Museum (Natural History), their registered numbers being quoted in square brackets. Except where otherwise stated, the figures are drawn natural size.

PLATE I.

FIG. 1. *Sphenophyllum speciosum* (Royle). Page 36. [V. 4190.]

FIG. 1*a*. *S. speciosum* (Royle). A single leaflet. × 3. P. 36. [V. 4190.]

FIG. 2. *Lepidodendron Pedroanum* (Carr.). P. 158. [V. 230.]

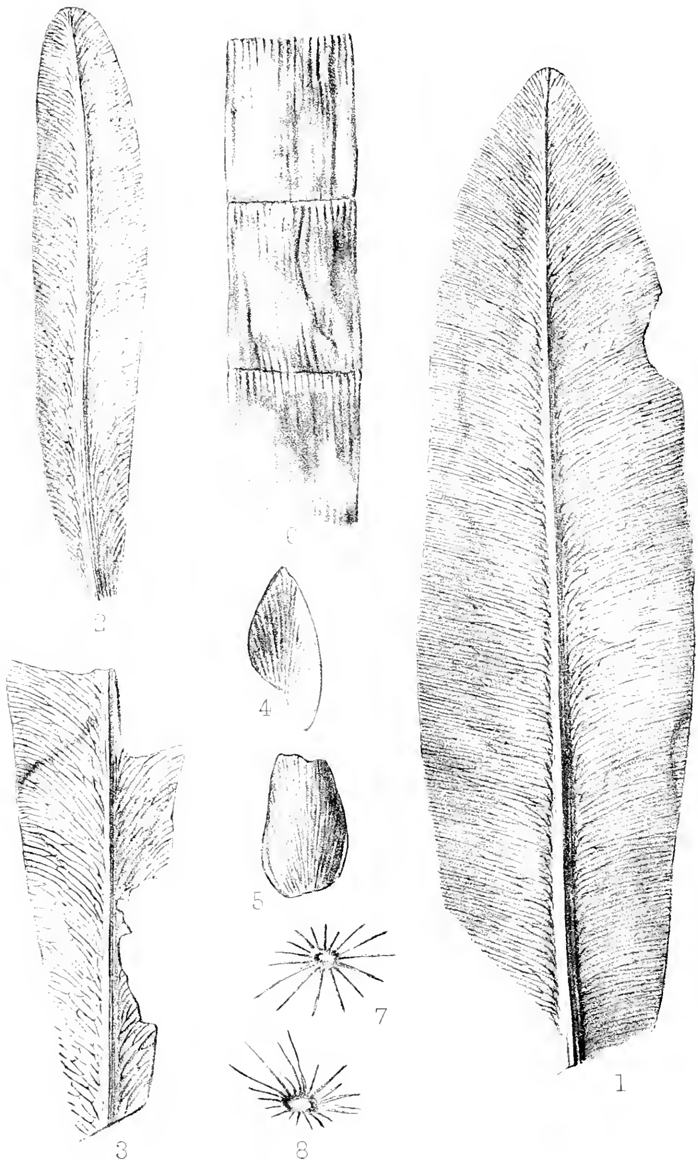


G.M.Woodward del et lith   West, Newman imp

Figs 1, 1a Sphenophyllum   2. Lepidodendron

PLATE II.

FIG. 1. *Glossopteris Browniana*, Brong. Page 55.	[V. 7281.]
FIG. 2. *G. Browniana*, Brong. P. 55.	[41,175.]
FIG. 3. *G. Browniana*, Brong. P. 55.	[V. 7281.]
FIG. 4. Scale-leaf of *G. Browniana*, Brong. P. 44.	[V. 7211.]
FIG. 5. Scale-leaf of *G. Browniana*, Brong. P. 44.	[V. 7211.]
FIG. 6. *Phyllotheca australis*, Brong. P. 19.	[V. 7285.]
FIG. 7. *P. australis*, Brong. P. 20.	[V. 7286.]
FIG. 8. *P. australis*, Brong. P. 20.	[V. 7215.]



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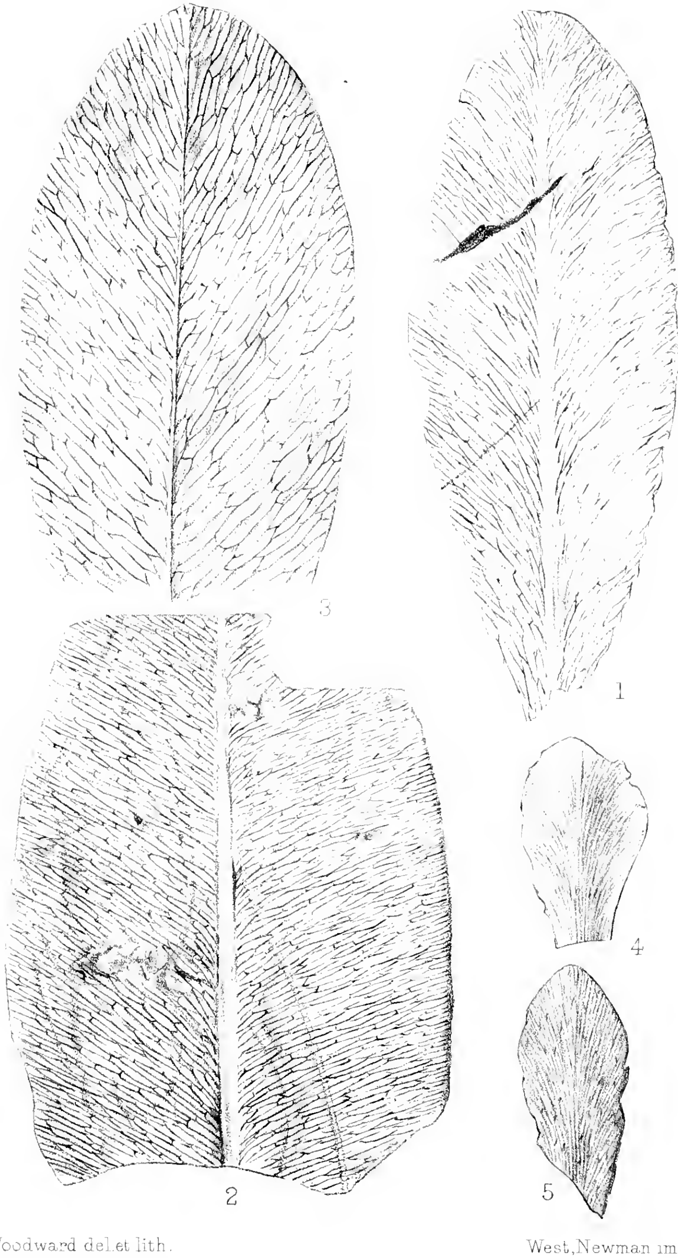
Figs 1–5 Glossopteris. 6–8 Phyllotheca.

PLATE III.

FIG. 1.	*Glossopteris Browniana*, Brong. Page 56.	[52,812.]
FIG. 2.	*G. Browniana*, Brong. P. 56.	[V. 7207.]
FIG. 3.	*G. conspicua*, Feist. P. 87.	[V. 2465.]
FIG. 4.	*Gangamopteris cyclopteroides*, Feist. P. 110.	[V. 3776*m*.]
FIG. 5.	*G. cyclopteroides*, Feist. P. 110.	[V. 3776*n*.]



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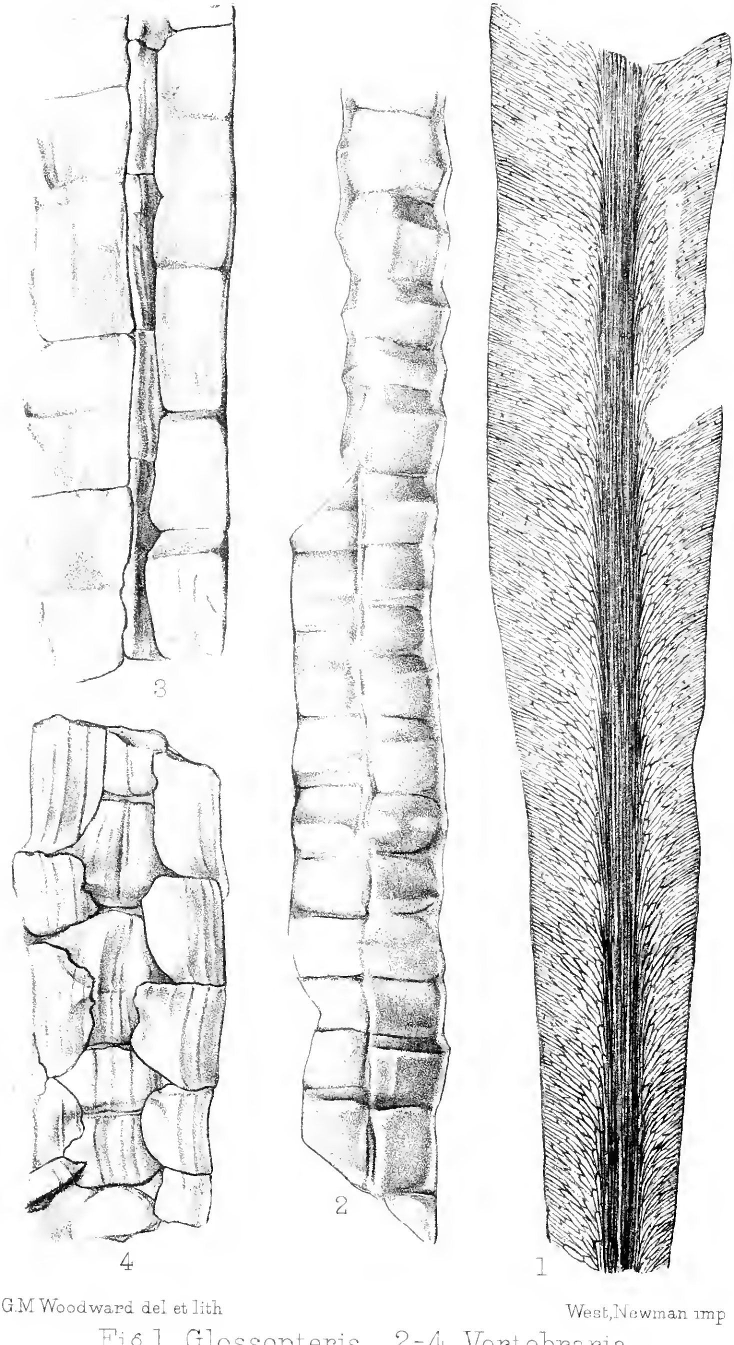
Figs 1-3 Glossopteris. 4-5 Gangamopteris.

PLATE IV.

Fig. 1.	*Glossopteris stricta*, Bunbury. Page 77.	[V. 7145.]
Fig. 2.	*Vertebraria indica*, Royle. P. 99.	[V. 4189.]
Fig. 3.	*V. indica*, Royle. P. 99.	[V. 7208.]
Fig. 4.	*V. indica*, Royle. P. 100.	[V. 7212]



G. M. Woodward del et lith

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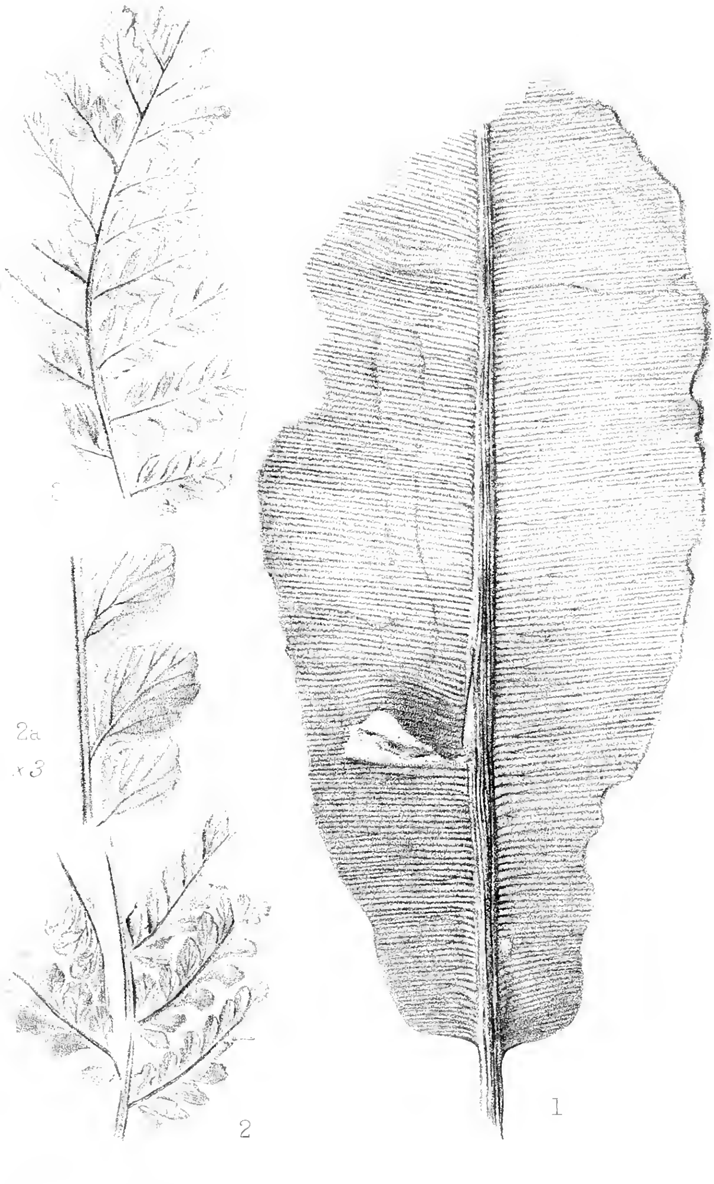
Fig 1. Glossopteris. 2-4 Vertebraria.

PLATE V.

FIG. 1. *Tæniopteris danæoides* (Royle). Page 122.		[V. 4191.]
FIG. 2. *Sphenopteris lobifolia*, Morris. P. 138.		[V. 7288.]
FIG. 2*a*. *S. lobifolia*, Morris. × 3. P. 138.		[V. 7288.]
FIG. 3. *S. lobifolia*, Morris. P. 138.		[V. 6251.]



G M W. del et lith West, Newman imp

Figs 1 Tæniopteris. 2, 2a, 3 Sphenopteris

PLATE VI.

Fig. 1. *Neuropteridium validum*, Feist. Page 119. [V. 227.]

Fig. 2. *Noeggerathiopsis Hislopi* (Bunb.). P. 184. [V. 3776*w*.]

Fig. 3. *N. Hislopi* (Bunb.). P. 184. [V. 3776*y*.]

Fig. 4. Rhizome of doubtful attribution. P. 97. [V. 7206.]

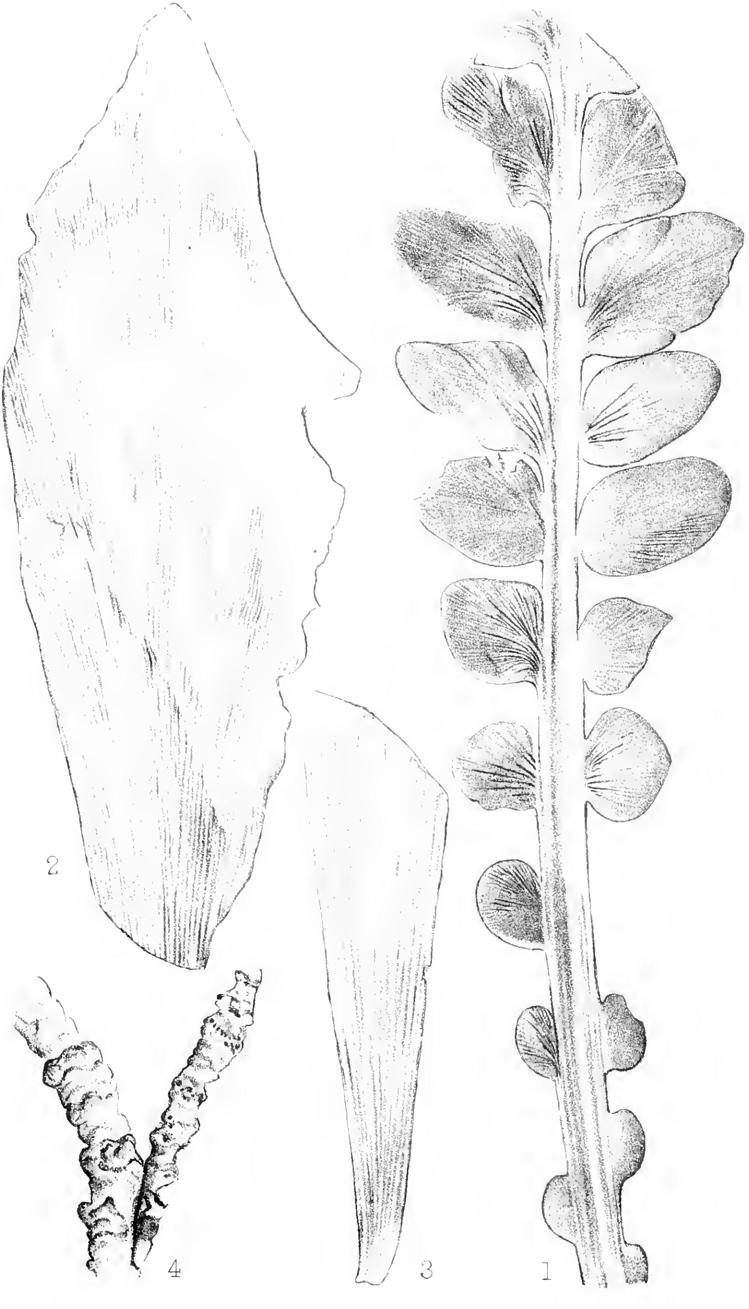


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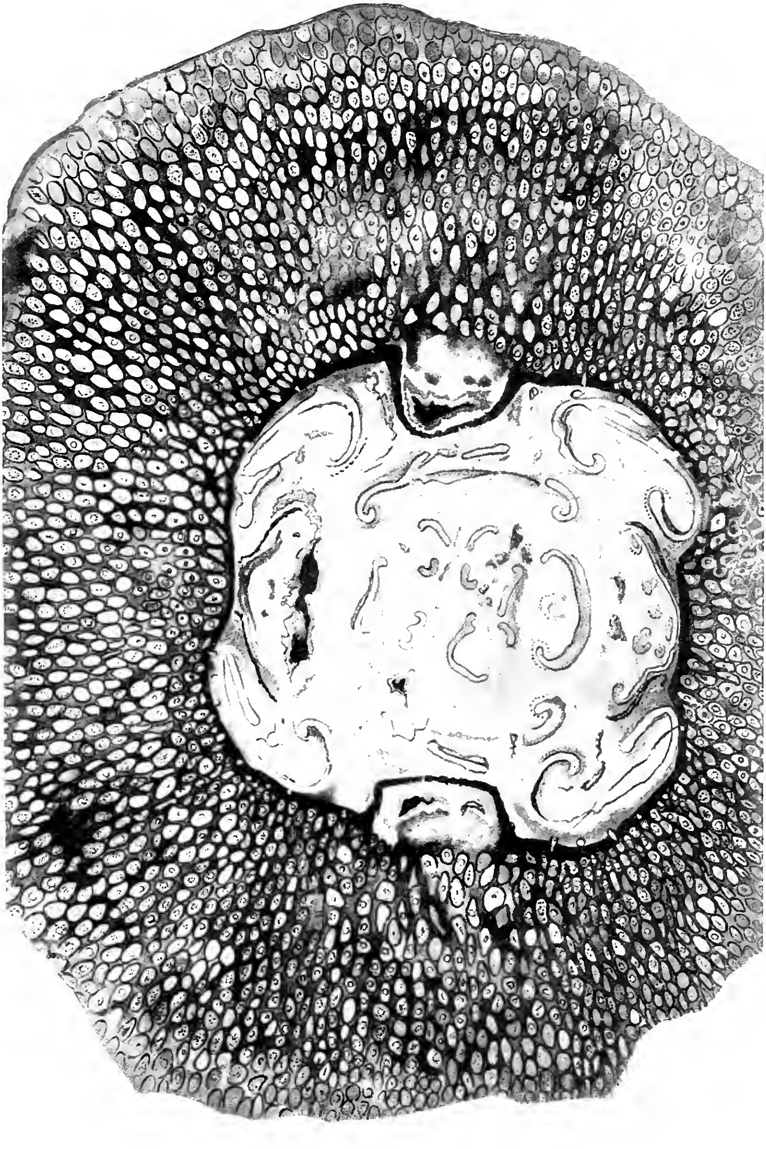
Fig. 1. Neuropteridium. 2-3 Noeggerathiopsis.
4 Rhizome.

PLATE VII.

Psaronius brasiliensis, Unger. Page 151. [V. 9002.]



Psaronius brasiliensis

PLATE VIII.

FIG. 1. *Sigillaria Brardi*, Brong. Page 174. [V. 3623.]

FIG. 2. *Noeggerathiopsis Hislopi* (Bunb.). P. 184. [V. 7233.]

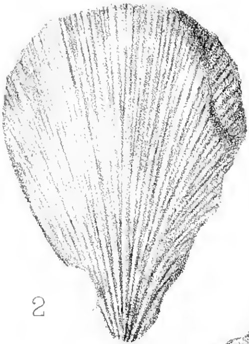


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Fig. 1. Sigillaria 2. Nœggerathiopsis.

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